Table E-8.
Species Included in Benefit and Variable Designations

V1 White shrimp	V7 Largemouth bass
V2 Brown shrimp	V8 American alligator
V3 Oyster	V9 Muskrat
V4 Gulf menhaden	V10 Mink
V5 Spotted seatrout	V11 Otter
V6 Atlantic croaker	V12 Dabbling ducks

The HSI values were averaged across all cells, for each habitat type, for each species, being used to determine habitat quality for that zone. Each species was weighted based on its relative importance in determining habitat quality for a specific habitat type. For instance, in the fresh/intermediate model, brown shrimp, oyster, and spotted seatrout are not used (or weighed with a zero) because they are not important in determining habitat quality in that zone.

Benefits Protocol B6--Selected Stakeholder Interests--includes features that reflect aspects of ecosystem change which are of specific interest to stakeholders or resource agencies. The features included here will likely change as the decision-making process proceeds and issues arise for which information regarding alternative performance is required.

6.0 SELECT A FINAL ARRAY OF COASTWIDE FRAMEWORKS THAT BEST MEETS PLANNING OBJECTIVES (TO BE ACCOMPLISHED AFTER PUBLIC COORDINATION) (PHASE V)

The PDT created the coastwide frameworks that were composed from each province and evaluated them using the Institute for Water Resources (IWR)-Plan computer program (Version 3.3, USACE). The automated program grouped the 32 subprovince frameworks into thousands of different combinations. The program then performed a cost effectiveness and incremental cost analysis (CE/ICA) using outputs/benefits and the estimated costs, that had been previously developed in the initial plan formulation phases, summed for the combined groups restoration features.

The benefits of the project alternatives are defined in ecological habitat units. Consequently, the analytical approach selected produced a comparison of costs expressed in dollars to benefits stated in habitat units. A CE/ICA was performed using this data.

In the cost-effectiveness analysis, the frameworks were assessed according to their ability to produce total ecological outputs for a given cost level. Frameworks that maximize output per dollar spent were retained, while all other frameworks were eliminated. The result is a listing of frameworks that achieve each output level at the lowest cost, or an efficient frontier. The cost-effectiveness assessment was followed by incremental cost analysis, which calculated cost changes as the level of output increased. Incremental cost is the additional cost of each change in the level of output. The array of frameworks show the additional cost per unit (or marginal cost) rising as output rises. Increases in incremental costs, combined with other selection criteria, facilitated framework selection in the absence of a deterministic rule.

The development of multiple ecological metrics allowed the PDT greater flexibility in the evaluation of the ecological trade-offs and efficiencies between alternative combinations. The PDT also employed a tiered incremental analysis of the alternative frameworks using the IWR-Plan. The tiered analysis addressed the optimization of alternative frameworks first in each subprovince of the coastal zone. Then, utilizing the optimal frameworks for each subprovince, the optimal framework combinations for the entire Louisiana coastal zone were developed. This methodology allowed both incremental and spatial optimization to occur in framework selection across the coast.

The cost and benefit input, though based on features that for the purpose of this study effort are surrogates for the ultimate projects that will be detailed in future documents, is critical to the task of identifying the most effective and appropriate system restoration framework to work from. With this analysis, the PDT was able to identify a final array of coastwide system frameworks that were most cost effective (i.e. those frameworks that held potential to produce the greatest amount of benefits in comparison to its cost). Frameworks that could maximize output per dollar spent were retained, while all other frameworks were eliminated.

6.1 Cost Effectiveness and Incremental Cost Analysis

The benefits of this project were defined in habitat units. Consequently, a CE/ICA was performed since this allowed the comparison of benefits measured in habitat units and costs measured in dollars.

A number of restoration features were developed for various portions of the coastal area. These features were combined to form frameworks. Many of the proposed features cannot be combined, while others do not function effectively alone (without other features in place). Also, many features produce more or less benefit--or have higher or lower costs--when combined. These interactions were accounted for when calculating the benefits and costs of each framework.

In the cost-effectiveness analysis, the frameworks were assessed according to their ability to produce output for a given cost level. Frameworks that maximized output per dollar spent were retained, while all other frameworks were eliminated. The result was a listing of frameworks that achieved each output level at the lowest cost, or an efficient frontier.

The cost-effectiveness assessment was followed by incremental cost analysis. Incremental cost is the additional cost of each change in the level of output. Changes in incremental costs, combined with other selection criteria discussed below, facilitated framework selection in the absence of a deterministic rule (such as maximizing net benefits, as is done in National Economic Development analysis).

Potential economic impacts of the frameworks were grossly estimated and taken into consideration in project selection as follows. After the CE/ICA was completed, economic impacts of frameworks in the final array were estimated on a gross basis to inform the PDT of the magnitude of these effects. The effects were then used as tiebreakers to select a recommended framework from the list of cost-effective frameworks.

The costs and benefits of the frameworks were amortized over a 50-year period of analysis at the current Federal discount rate of 5.875 percent. Costs were estimated at the October 2003 price level.

6.2 Combinability of (Alternatives) Frameworks

An initial function performed by the IWR-Plan software was the generation of all possible framework configurations. Utilizing the costs and benefit outputs developed for the various subprovince frameworks and criteria established for their combinability, the program assembled all the possible coastwide framework combinations. The primary determining factor for the combinability of various subprovince alternative frameworks into coastwide alternatives was the availability of Mississippi River system resources in the form of freshwater. The Districts Hydraulics and Hydrologic Engineering Branch personnel estimated the amount of available Mississippi River flow for diversion. The combinability criteria identified that combination of subprovince frameworks that would exceed available resources to implement them. Future studies will be preformed early in the next phase to verify the total amount of river flow that can be diverted without adversely impacting the system.

6.3 Hydraulic Combinability Criteria

Monthly median flows for each diversion were developed for use by the Numerical Modeling Team. These flows were used for the water budget and estimates of induced shoaling on the Mississippi River. Monthly median flows for existing diversions at Davis Pond, Caernarvon, Naomi Siphon, and West Pointe a la Hache were also computed. Monthly median flows for the approved West Bay Sediment Diversion, a first year CWPPRA project, were also included in the analysis; it was assumed that the diversion was full size, or 50,000 cfs diversion at the 50 percent exceedence stage.

The monthly median Mississippi River flow at Tarbert Landing was developed from calendar year computed flow records for 1993-2002. The flows were adjusted, where necessary, to ensure representation of present operation of the Old River Control Complex at 70-30 latitude flow. These flows represented the amount of water in the Mississippi River available for diversion.

The flows for each diversion were organized by Mississippi River mile, from upstream to downstream for each alternative. For each subprovince framework, the monthly median flow through a diversion was subtracted from the Mississippi River monthly median flow present upstream of the diversion to produce the Mississippi River monthly median flow downstream of the diversion. This process was continued from the most upstream diversion for each alternative downstream to Venice, mile 10.7 AHP.

The frameworks for Subprovinces 1 and 2 represent the full extent of proposed diversions from the Mississippi River. As a result, for a Mississippi River water budget, it is necessary to combine flows from one alternative from Subprovince 1 with flows from one alternative from Subprovince 2, which produces 81 possible combinations of alternatives. The flows for each alternative were then added to produce all of the possible combined diversion flows to subtract from the monthly median flow at Tarbert Landing, resulting in a flow at Venice for the alternative combination.

A fixed percent diverted was computed for the West Bay Sediment Diversion based on the monthly median flow and the flow available upstream of this diversion. This percentage was applied to the flow at Venice for each framework combination to achieve the flow remaining in the Mississippi River. The ratio of the monthly median flow diverted to the monthly median flow at Tarbert Landing for June was developed for the alternative framework combinations.

The April 1990 report Louisiana Coastal Area, Louisiana, Feasibility Study on Land Loss and Marsh Creation, Volume 2, appendix B, contains annual shoaling estimates for the Mississippi River navigation channel for large-scale and small-scale diversions ranging from 594 cfs to 100,000 cfs at the 50 percent exceedence stage. These shoaling estimates were plotted with the percent diversion flow, and a power curve fit through the points. The resulting equation,

$$Y = 1.087E^{7} * X^{1.149}$$

where Y = annual shoaling estimate (cubic yards) and X = percent Tarbert flow diverted at the 50 percent exceedence stage (cfs) has an R^2 of 0.98. This equation was applied to the framework combination percentages to compute the shoaling estimate for each framework combination.

An upper bound trendline was developed for the shoaling estimate data from the April 1990 report. The resulting equation,

$$Y = 1.5E^{7} * X + 1.94E^{-9}$$

was also applied to the framework combination percentages to compute the shoaling estimate for each alternative combination to produce a potential shoaling range. An additional maintenance cost for each framework combination was developed based on these shoaling estimates and was entered into IWR-Plan as an additive cost to be applied to the specific framework combinations.

The CE/ICA was done using implementation costs (construction and real estate acquisition) traded against ecological benefit output units. The comparison of the coastwide frameworks was based on the summation of subprovince framework ecological benefits versus cost as provided by the IWR-Plan analysis. The CE/ICA was used to filter the coastwide frameworks down to an array of the ten most cost-effective. These frameworks were presented in four public meetings held across coastal Louisiana in August 2003.

A description of the economic values to be lost in the future without-project condition was also developed. A database from a previous USACE report was used to determine the potential economic impact of erosion. This database contains stage-damage data that were aggregated on the basis of water resource units (WRUs), delineations of the region where areas are grouped by economic and hydrologic characteristics. The stage-damage data for each WRU were developed in 1980 under contract with CH2M Hill Inc., as part of the Mississippi River and Tributaries (MR&T) Flood Damage Estimation System. The structural damage categories for each WRU include: residential, commercial, industrial, public, and farm buildings. After receiving an existing and future condition stage associated with each WRU provided by Hydrology and Hydraulics (H&H) Branch, the damages for the structural damage categories adjusted to current price levels by using price indexes from the Engineering News Record (ENR). For the agricultural portions of the study area, the database includes the cleared acreage flooded along with the crop distribution per cleared acre for each WRU. Updated damage rates per acre will then be obtained from previous studies to determine to the total agricultural damage for a given elevation or stage. The agricultural damages will be added to the structural damage at a given stage to estimate the total potential economic impact of coastal erosion.

To the extent possible, potential economic impacts of the frameworks were grossly estimated and taken into consideration in the selection. After the CE/ICA was completed, both positive and negative economic impacts in this final array were estimated on a gross basis to inform decision makers of the magnitude of any economic effects of the final frameworks.

For the development of the final array, cost-effectiveness criteria were also applied. The combined weighted ecological outputs provided by the models and benefit protocols were documented for each coastwide framework. The combined weighted outputs and costs for each framework was also displayed and ordered by cost. The decision factors provided the basis for the premises that describe the various changes that occur across the coast and the programmatic issues that were of importance to the framework selection process. The primary factors of interest were ecological benefit versus cost, and an assessment of economic effects. Six benefit groups analyzed these factors from the perspective of their expertise. The groups looked at: 1) Ecosystem Quality; 2) Composite Benefits; 3) Land (acres) Created or Preserved; 4) Weighted Fish and Wildlife Benefits; 5) Nitrogen (N) Removal; and 6) Values Determined by Decision Makers.

6.4 Framework Effectiveness

6.4.1 <u>Introduction</u>

The PDT utilized the data developed through the analyses to assess the effectiveness of the various frameworks. The model and benefit analyses focused on the individual framework combinations developed in each of the four subprovinces. Outputs from these tools provided specific assessments of the relative effectiveness of the frameworks at meeting the study objectives at the subprovince level.

6.4.2 Comparison of Frameworks

6.4.2.1 Framework outputs by subprovince

Given the programmatic nature of the LCA Plan, it was understood that the results of the modeling effort would serve primarily to differentiate among alternatives with respect to their relative effects on important resources. The LCA PDT acknowledges that the model-based projections for fish and wildlife outputs may not accurately forecast change. It was further understood that accurate estimates of the effects of particular restoration features could only be developed at the project level, when critical information such as the location, size, and operation of such features would be available. It is, however, believed that the model outputs are usable in the plan formulation process because they are derived from a consistent set of assumptions and protocols. Thus, the model outputs presented in this section do allow for measure of the incremental differences between alternatives.

The outputs for each of the 32 frameworks in the four subprovinces are represented below in several forms. These outputs provide the basis for determining the various benefit values described by the benefit protocols in the Plan Formulation Rationale section of this report. The bar graphs presented (**figures E-4 to E-22**) for the frameworks in each subprovince represent the components of environmental output that make up the benefit value described by the B2 benefit protocol. The B2 value was utilized to supply the benefit component of the cost effectiveness analysis, which is documented in the next section of this report. These desktop model outputs also provided a means of comparison of the relative effects of each framework.

A comparison of the year 50 habitat composition for the frameworks in each subprovince as compared to the No Action alternative at year 50 is presented in **tables E-9, E-12, E-15, and E-18**. Immediately following the habitat composition table in each subprovince is a table displaying the total production-vegetation graph for the frameworks in the respective subprovinces (**tables E-10, E-13, E-16, and E-19)**. This table displays the total anticipated productivity of vegetation in square kilometer production units as it is projected to change over 10-year increments for the 50-year planning period. Additionally, a table is provided, for each subprovince, of expected suitability for 12 individual species for each alternative within that subprovince, based on the conditions produced by each particular alternative framework (**tables E-11, E-14, E-17, and E-20)**.

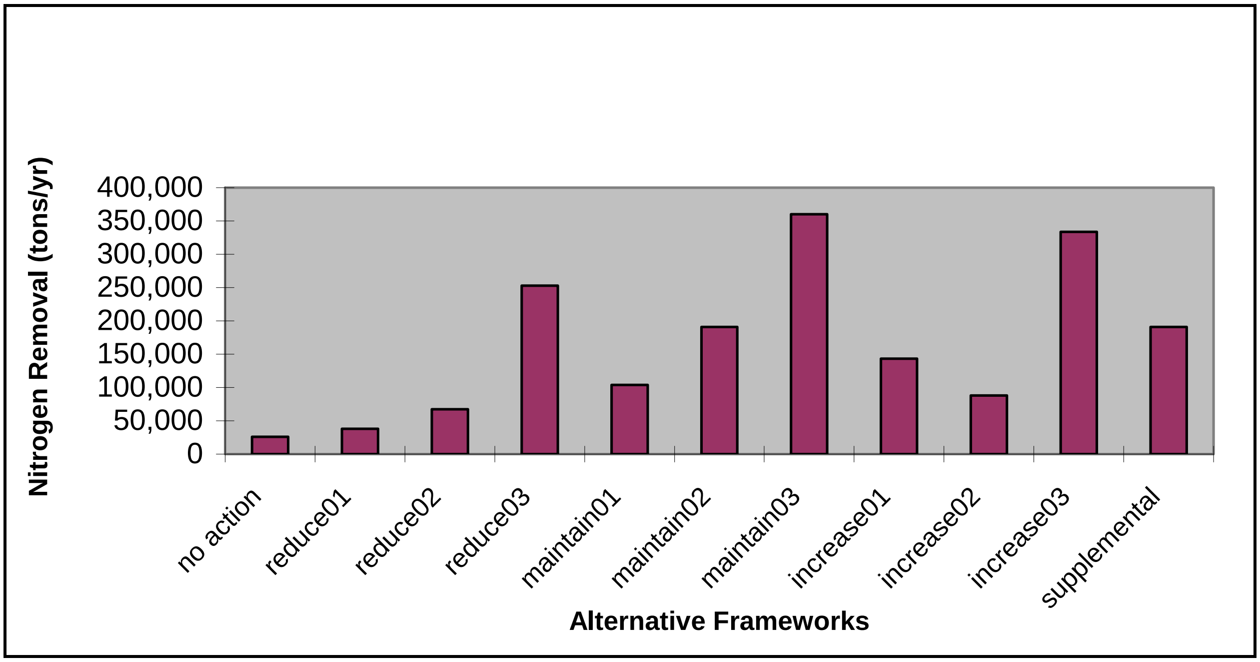


Figure E-4. Nitrogen Removal at Year 50 for Subprovince 1 Alternatives.

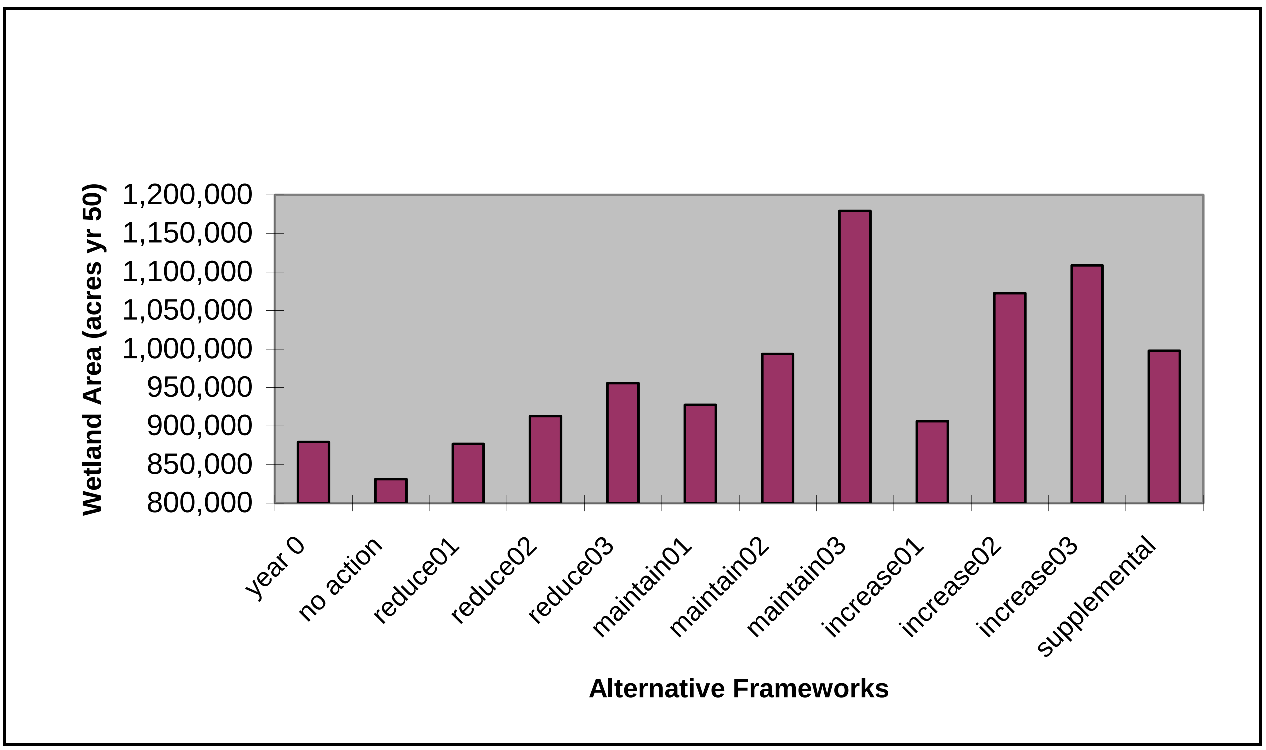


Figure E-5. Land Building at Year 50 for Subprovince 1 Alternatives.

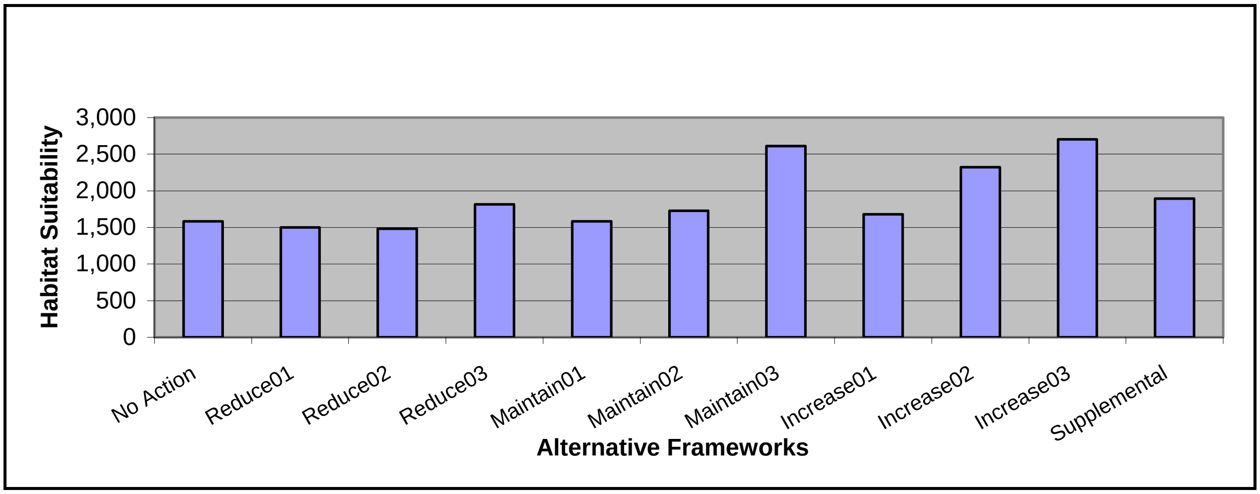


Figure E-6. Habitat Suitability for Lower Salinity Species at Year 50 for Subprovince 1.

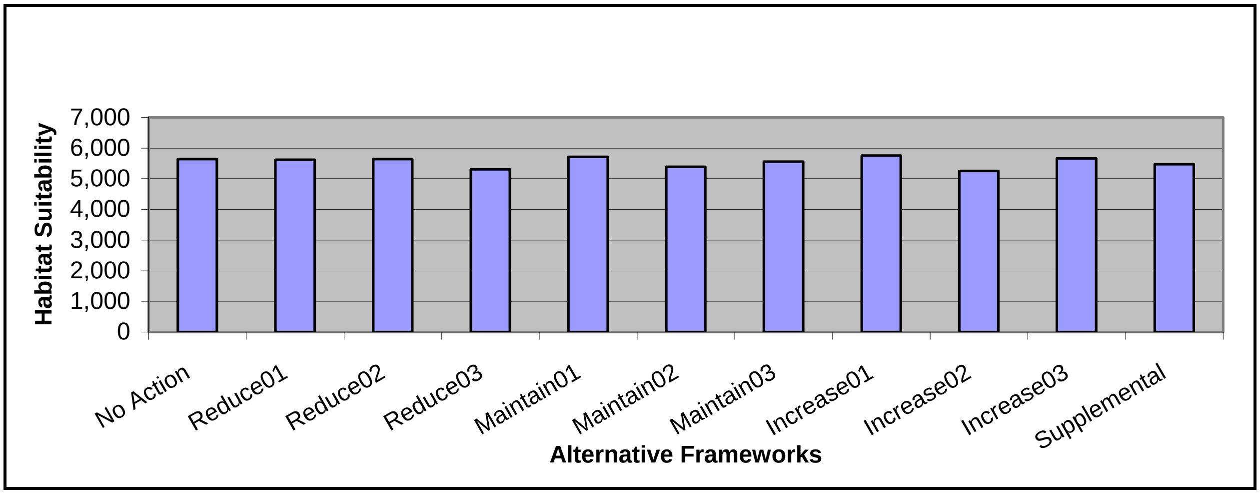


Figure E-7. Habitat Suitability for Moderate Salinity Species at Year 50 for Subprovince 1.

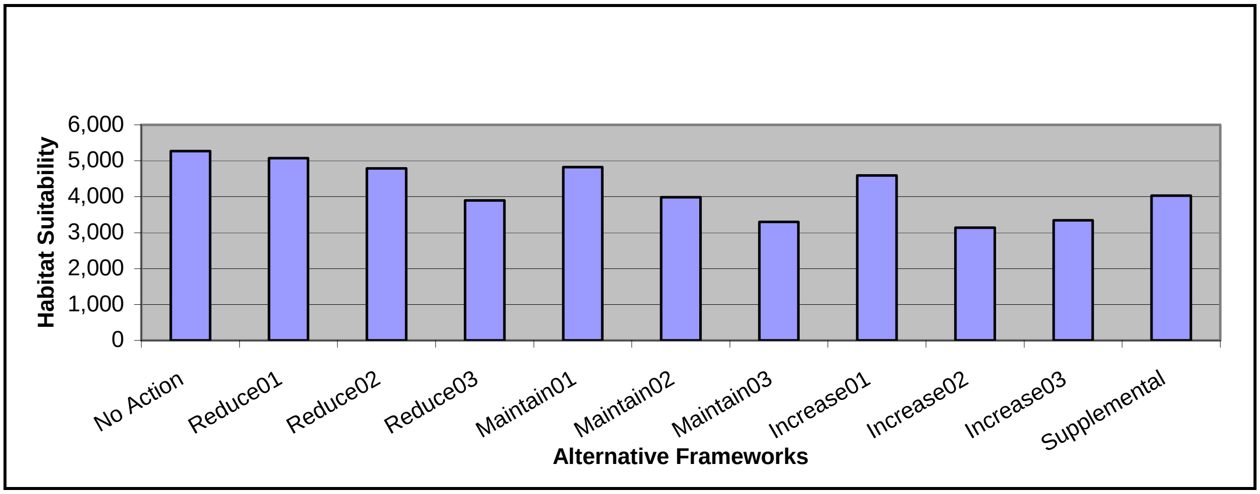


Figure E-8. Habitat Suitability for Higher Salinity Species at Year 50 for Subprovince 1.

Table E-9.
Percent Habitat Composition at Year 50 for Subprovince 1 Alternatives.

	Fresh Marsh	Intermediate Marsh	Brackish Marsh	Saline Marsh	Swamp	Upland	Water
No Action	5.7	2.7	3.9	1.5	9.0	14.0	63.2
Reduce 1	6.3	3.5	3.4	1.8	9.2	14.0	61.9
Reduce 2	6.8	3.4	4.3	1.5	9.1	14.0	60.9
Reduce 3	11.0	3.4	1.7	1.4	8.8	14.0	59.7
Maintain 1	6.3	4.0	5.0	1.4	8.8	14.0	60.5
Maintain 2	7.2	6.2	1.7	1.5	9.1	14.0	60.4
Maintain 3	19.4	3.4	1.3	0.0	8.3	14.0	53.6
Increase 1	6.6	3.2	2.6	3.0	9.2	14.0	61.1
Increase 2	14.6	4.3	1.4	0.6	8.7	14.0	56.5
Increase 3	17.0	3.4	1.3	0.6	8.2	14.0	55.5
Supplemental	8.3	7.4	1.7	1.4	8.7	14.0	58.6

Table E-10.
Total Production of Vegetation With the Subprovince 1 Alternatives (km^2 production units).

	Year 00	Year 10	Year 20	Year 30	Year 40	Year 50
No Action	706.2	765.4	757.2	748.7	740.8	732.3
Reduce 1	706.2	789.4	788.6	787.1	783.9	781.4
Reduce 2	706.2	814.5	829.2	841.2	851.3	859.5
Reduce 3	706.2	867.4	905.2	941.1	973.8	1,006.0
Maintain 1	706.2	829.8	838.5	846.0	852.2	858.0
Maintain 2	706.2	833.5	860.3	884.2	905.4	923.7
Maintain 3	706.2	1,000.6	1,120.2	1,236.4	1,340.2	1,457.3
Increase 1	706.2	805.6	810.5	812.1	813.1	814.1
Increase 2	706.2	1,001.1	1,084.8	1,152.5	1,211.2	1,267.6
Increase 3	706.2	965.5	1,056.2	1,143.0	1,219.1	1,304.5
Supplemental	706.2	858.0	905.5	948.9	989.4	1,028.3

Table E-11.
Cumulative Habitat Suitability of Subprovince 1 Alternatives at Year 50.

	No Action	Reduce 01	Reduce 02	Reduce 03	Maintain 01	Maintain 02	Maintain 03	Increase 01	Increase 02	Increase 03	Supplemental
bass	19,875.1	19,284.2	18,988.5	24,375.3	19,227.2	24,142.5	30,279.9	22,037.2	29,680.6	31,515.5	24,537.5
croaker	44,691.8	44,659.4	44,809.1	43,297.2	44,851.0	43,585.3	43,044.0	45,173.8	42,971.6	43,591.2	43,272.4
trout	35,048.8	33,509.1	30,602.1	26,110.4	31,885.5	26,180.5	19,897.9	29,874.3	19,897.9	19,897.9	26,175.3
menhaden	44,570.6	44,502.4	44,762.4	41,010.9	44,933.6	42,230.6	39,458.4	45,303.7	37,641.7	39,868.5	42,237.8
brown shrimp	27,822.6	27,092.2	26,896.9	24,044.1	26,769.0	25,256.4	23,700.5	26,484.5	22,641.9	24,056.9	25,599.0
white shrimp	33,582.4	33,576.9	33,421.3	31,745.9	33,627.5	33,074.5	33,412.2	33,974.9	31,990.8	34,216.8	33,593.2
oyster	31,703.0	31,154.2	30,126.4	23,909.8	29,477.7	24,062.1	20,692.4	28,006.8	19,414.6	20,692.4	24,060.8
mink	6,652.9	6,220.9	6,393.5	6,640.9	6,595.5	6,424.5	7,391.0	6,518.5	7,239.8	7,514.5	6,592.9
otter	6,509.0	6,187.4	6,338.3	6,629.3	6,571.0	6,563.6	7,376.5	6,416.9	7,001.9	7,459.2	6,774.5
muskrat	11,641.6	11,658.4	12,183.8	12,035.5	12,697.0	11,475.5	14,353.0	12,072.3	13,350.3	13,973.2	12,195.5
alligator	5,696.9	5,917.6	5,875.3	6,197.4	6,334.7	6,624.0	8,848.5	5,601.4	7,281.9	8,885.3	7,619.4
duck	6,696.2	6,662.3	6,564.6	7,775.8	7,013.8	6,709.4	12,173.9	6,730.1	10,239.3	12,035.1	7,550.0

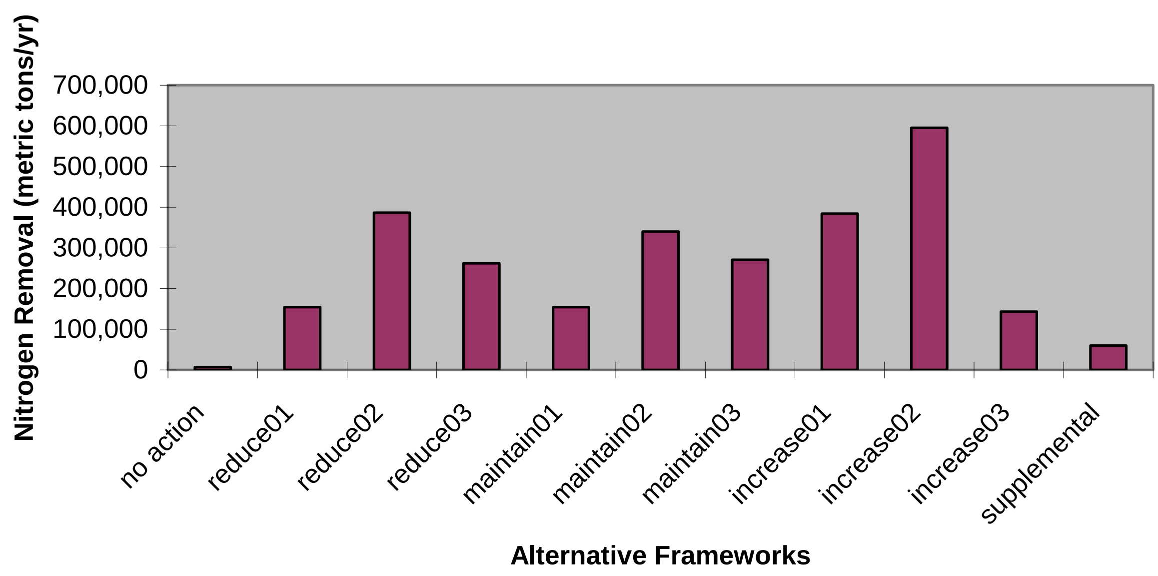


Figure E-9. Nitrogen Removal at Year 50 for Subprovince 2 Alternatives.

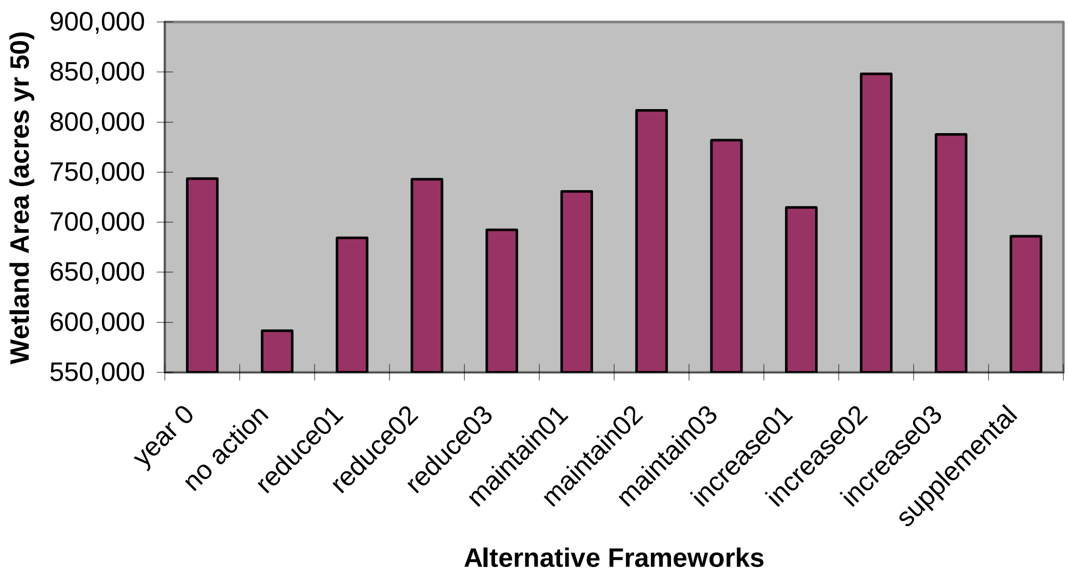


Figure E-10. Land Building at Year 50 for Subprovince 2 Alternatives.

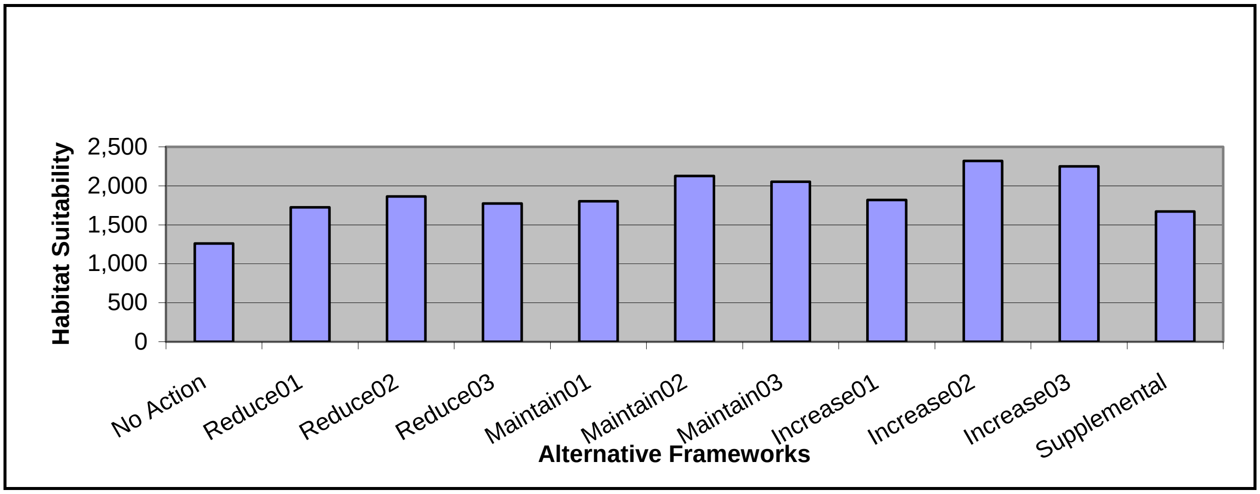


Figure E-11. Habitat Suitability for Lower Salinity Species at Year 50 for Subprovince 2.

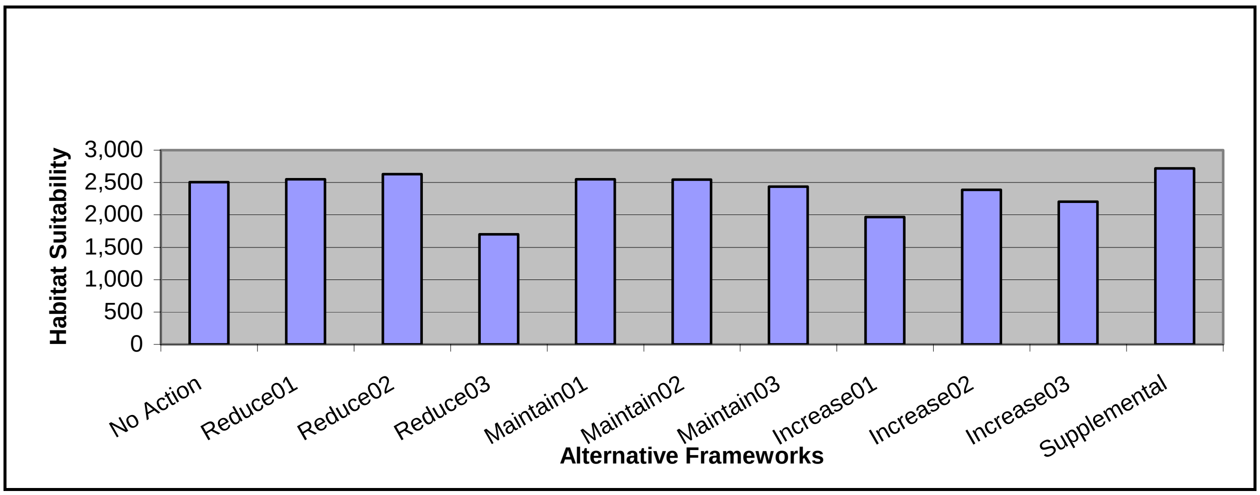


Figure E-12. Habitat Suitability for Moderate Salinity Species at Year 50 for Subprovince 2.

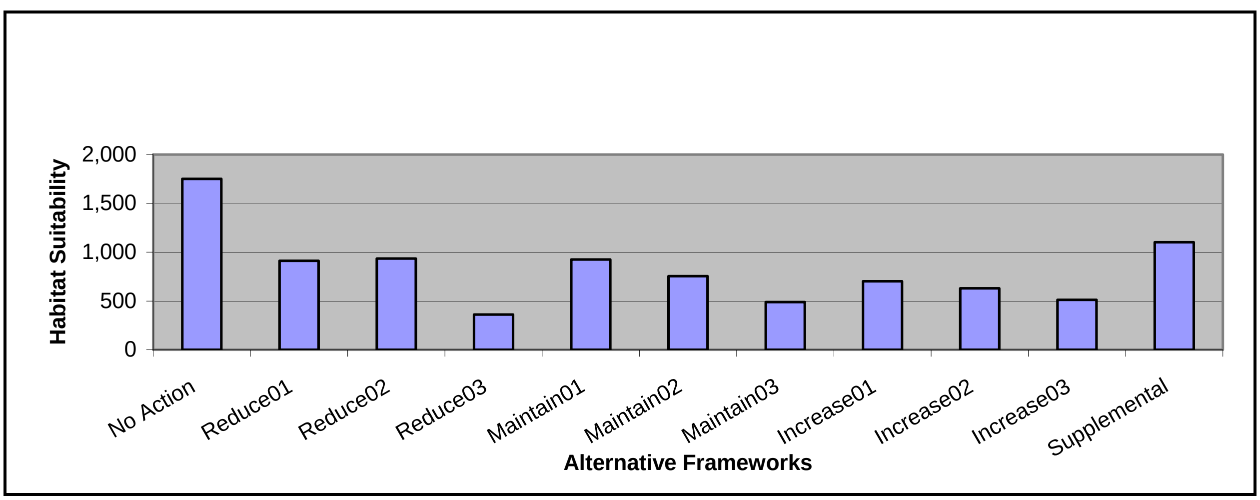


Figure E-13. Habitat Suitability for Higher Salinity Species at Year 50 for Subprovince 2.

Table E-12.
Percent Habitat Composition at Year 50 for Subprovince 2 Alternatives.

	Brackish Marsh	Fresh Marsh	Intermediate Marsh	Saline Marsh	Swamp	Upland	Water
No Action	0.0	14.2	2.9	0.0	15.9	18.1	48.9
Reduce 1	0.0	19.6	3.5	0.0	15.1	18.1	43.7
Reduce 2	0.0	23.7	3.3	0.0	14.4	18.1	40.4
Reduce 3	0.0	23.7	0.0	0.0	15.0	18.1	43.3
Maintain 1	0.0	22.1	3.8	0.0	14.8	18.1	41.1
Maintain 2	0.0	28.4	3.1	0.0	13.7	18.1	36.6
Maintain 3	0.0	28.6	1.1	0.0	13.9	18.1	38.3
Increase 1	1.1	24.2	0.0	0.0	14.6	18.1	42.0
Increase 2	0.0	34.1	0.0	0.0	13.2	18.1	34.6
Increase 3	0.0	27.2	3.8	0.0	12.9	18.1	37.9
Supplemental	0.0	16.1	6.8	0.0	15.3	18.1	43.6

Table E-13.
Total Production of Vegetation with the Subprovince 2 Alternatives (km^2 production units).

	Year 00	Year 10	Year 20	Year 30	Year 40	Year 50
No Action	720.4	721.5	660.7	610.2	569.9	537.5
Reduce 1	720.4	819.8	788.9	755.6	731.2	709.0
Reduce 2	720.4	769.7	781.3	801.4	820.5	838.2
Reduce 3	720.4	856.7	827.0	803.8	785.0	771.5
Maintain 1	720.4	849.2	841.3	824.5	792.8	785.4
Maintain 2	720.4	863.0	879.1	905.3	934.1	965.7
Maintain 3	720.4	869.0	873.2	885.4	899.5	921.5
Increase 1	720.4	869.9	880.0	852.6	838.0	823.1
Increase 2	720.4	935.2	978.5	1,031.5	1,072.0	1,074.0
Increase 3	720.4	827.3	876.2	908.1	840.5	969.5
Supplemental	720.4	806.2	788.0	752.9	719.1	683.8

Table E-14.
Cumulative Habitat Suitability of Subprovince 2 Alternatives at Year 50.

	No Action	Reduce 01	Reduce 02	Reduce 03	Maintain 01	Maintain 02	Maintain 03	Increase 01	Increase 02	Increase 03	Supplemental
bass	20,420.3	22,595.3	22,831.7	23,621.8	22,665.4	24,578.0	24,464.6	23,056.1	25,679.4	24,723.1	21,593.0
croaker	18,430.1	15,967.8	15,857.0	13,786.5	15,681.4	15,006.1	14,227.3	14,808.8	13,755.1	13,825.1	17,630.3
trout	3,335.3	2,762.0	2,758.5	558.2	2,762.0	558.2	558.2	2,610.4	558.2	558.2	4,713.7
menhaden	18,200.1	15,275.3	15,252.6	8,611.7	15,092.9	13,754.0	12,835.5	10,453.2	11,775.5	12,034.9	17,802.2
brown shrimp	14,168.0	12,545.8	12,724.6	7,201.0	12,621.4	12,672.6	9,073.6	9,566.7	10,874.1	9,209.5	13,564.8
white shrimp	20,226.7	20,460.2	20,807.0	12,095.2	20,039.7	19,850.7	19,792.4	14,096.9	18,644.3	15,678.8	19,908.7
oyster	3,213.4	1,206.8	1,225.1	513.7	1,206.8	513.7	513.7	1,304.6	513.7	513.7	1,193.8
mink	6,039.4	6,447.6	6,487.7	6,531.9	6,630.3	6,864.7	6,785.2	6,700.3	7,155.8	7,314.2	6,373.9
otter	5,858.3	6,336.8	6,362.3	6,209.6	6,520.6	6,742.7	6,533.8	6,365.7	6,758.7	7,050.8	6,376.7
muskrat	7,740.1	8,777.1	9,320.9	9,002.8	9,268.5	10,293.0	10,121.2	9,806.5	11,009.2	9,896.9	8,690.3
alligator	4,194.2	5,123.0	5,401.3	4,238.6	5,388.5	6,135.3	5,416.9	4,579.2	5,888.2	5,267.1	5,324.3
duck	5,924.8	7,126.8	7,958.8	7,678.5	7,468.3	9,448.3	9,500.2	8,007.9	11,441.9	9,277.7	6,544.9

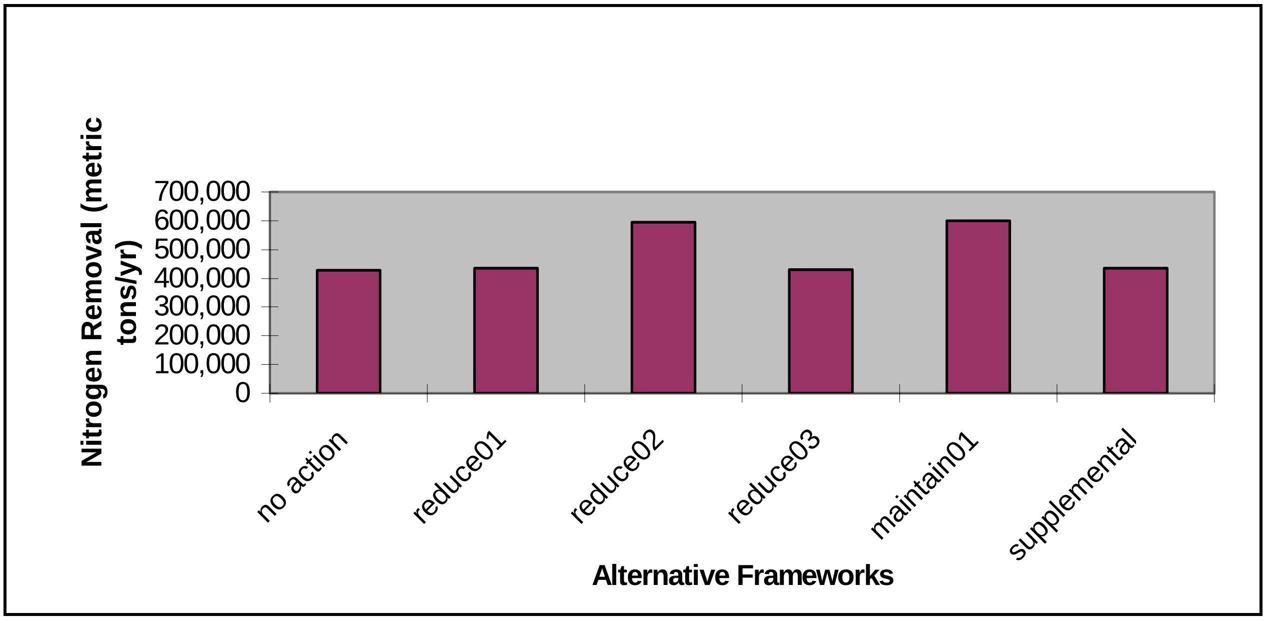


Figure E-14. Nitrogen Removal at Year 50 for Subprovince 3 Alternatives.

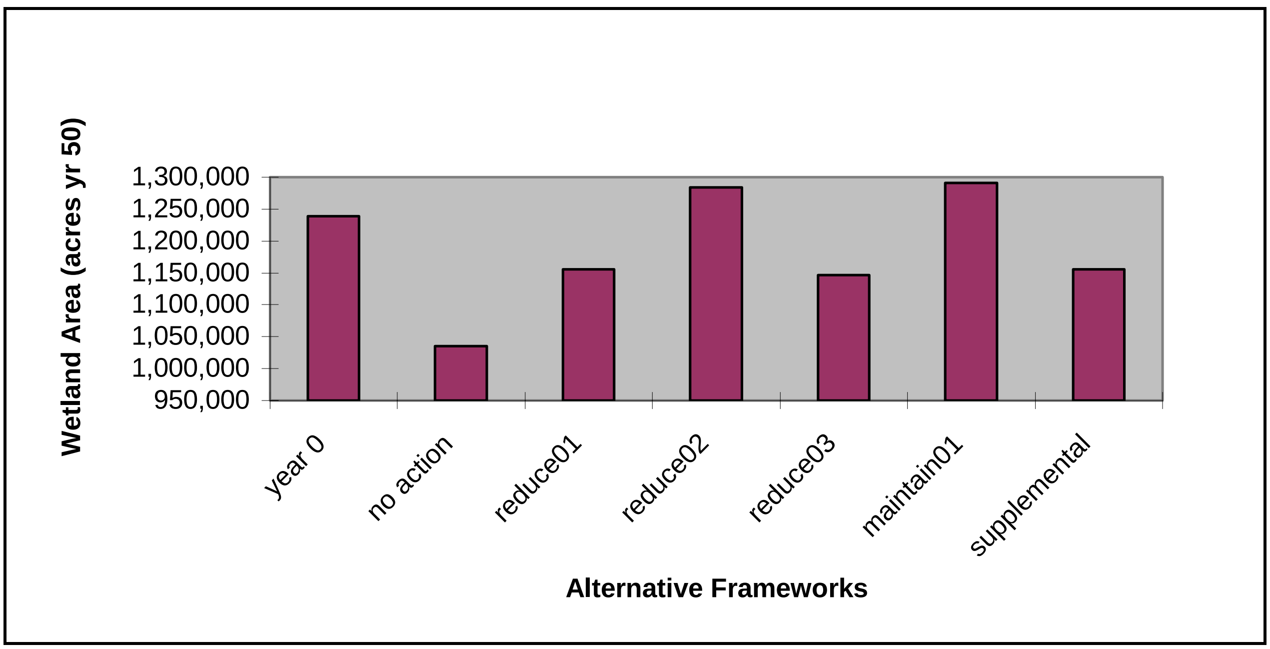


Figure E-15. Land Building at Year 50 for Subprovince 3 Alternatives.

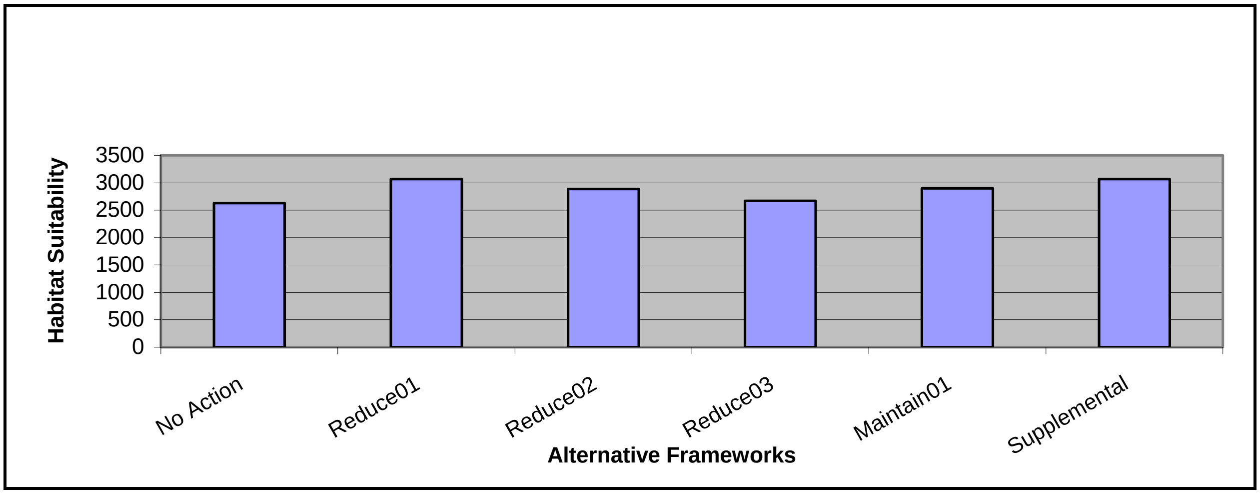


Figure E-16. Habitat Suitability for Lower Salinity Species at Year 50 for Subprovince 3.

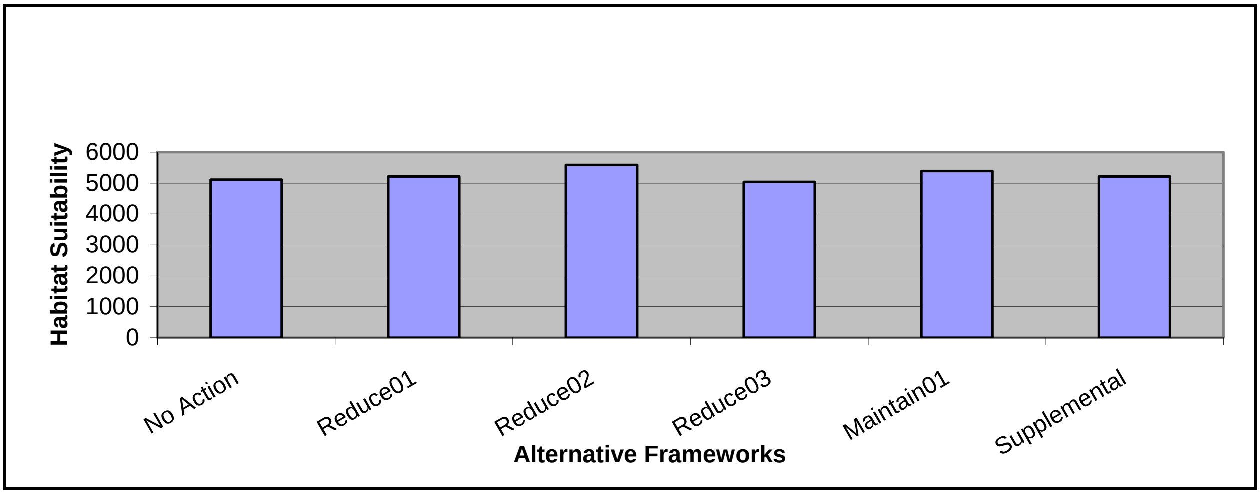


Figure E-17. Habitat Suitability for Moderate Salinity Species at Year 50 for Subprovince 3.

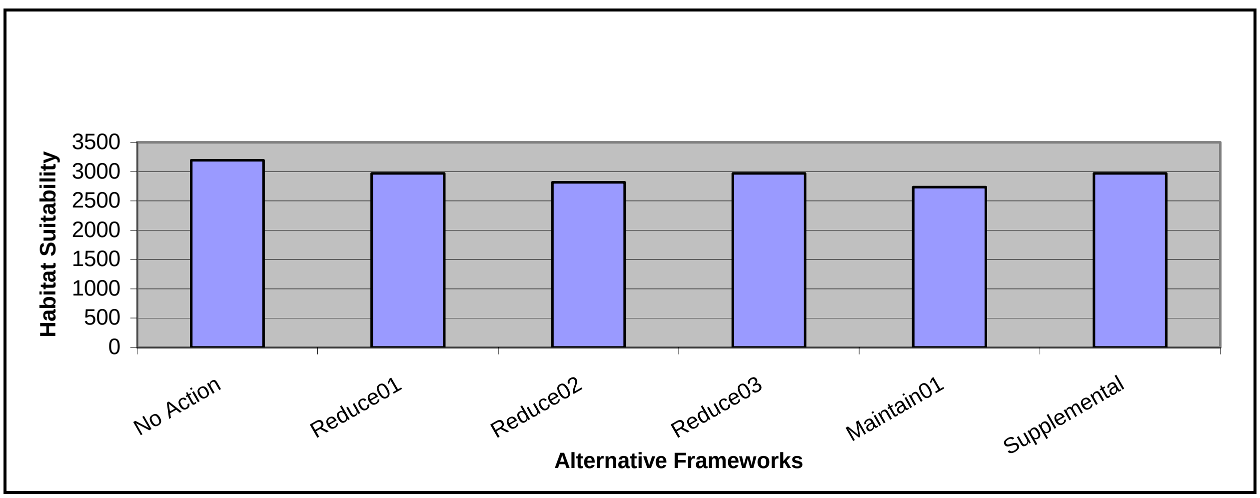


Figure E-18. Habitat Suitability for Higher Salinity Species at Year 50 for Subprovince 3.

Table E-15.
Percent Habitat Composition at Year 50 for Subprovince 3 Frameworks.

	Brackish Marsh	Fresh Marsh	Intermediate Marsh	Saline Marsh	Swamp	Upland	Water
No Action	1.5	1.2	22.8	0.2	12.4	10.0	51.9
Reduce 1	1.2	6.5	22.3	0.6	12.0	10.0	47.4
Reduce 2	7.3	6.2	22.3	0.0	11.5	10.0	42.7
Reduce 3	1.2	6.5	22.0	0.6	12.0	10.0	47.8
Maintain 1	7.3	8.9	19.6	0.0	11.8	10.0	42.5
Supplemental	1.2	6.5	22.3	0.6	12.0	10.0	47.4

Table E-16.
Total Production of Vegetation with the Subprovince 3
Frameworks (km^2 production units).

	Year 00	Year 10	Year 20	Year 30	Year 40	Year 50
No Action	1,570.9	1,512.5	1,414.1	1,306.1	1,202.2	1,106.2
Reduce 1	1,570.9	1,517.1	1,458.0	1,417.0	1,374.3	1,338.0
Reduce 2	1,570.9	1,635.6	1,643.0	1,649.1	1,666.4	1,693.0
Reduce 3	1,570.9	1,516.2	1,463.2	1,408.2	1,361.1	1,320.4
Maintain 1	1,570.9	1,686.9	1,694.5	1,701.9	1,717.3	1,746.3
Supplemental	1,570.9	1,517.1	1,468.0	1,417.0	1,374.3	1,338.0

Table E-17.
Cumulative Habitat Suitability of Subprovince 3
Alternatives at Year 50.

	No Action	Reduce 01	Reduce 02	Reduce 03	Maintain 01	Supplemental
bass	32,637.6	31,970.4	31,955.1	31,866.1	31,982.4	31,970.4
croaker	31,255.1	30,562.8	31,356.3	30,527.9	30,185.8	30,562.8
trout	17,684.0	15,468.3	15,596.3	15,473.4	15,617.5	15,468.3
menhaden	36,848.0	35,699.2	38,880.6	35,587.1	36,717.4	35,699.2
brown shrimp	27,767.3	26,890.0	28,010.5	26,831.1	26,666.5	26,890.0
white shrimp	37,917.5	37,221.0	39,239.3	37,088.7	38,396.9	37,221.0
oyster	10,837.4	10,733.5	6,449.5	10,733.5	6,447.9	10,733.5
mink	8,761.2	9,983.5	9,075.7	8,386.8	9,207.8	9,983.5
otter	9,638.0	11,107.0	9,853.1	9,182.6	9,799.6	11,107.0
muskrat	14,609.9	17,672.3	18,076.3	15,537.3	18,344.8	17,672.3
alligator	14,933.3	15,811.3	16,242.1	14,554.9	15,479.3	15,811.3
duck	10,224.6	12,540.2	12,672.3	10,992.1	13,231.3	12,540.2

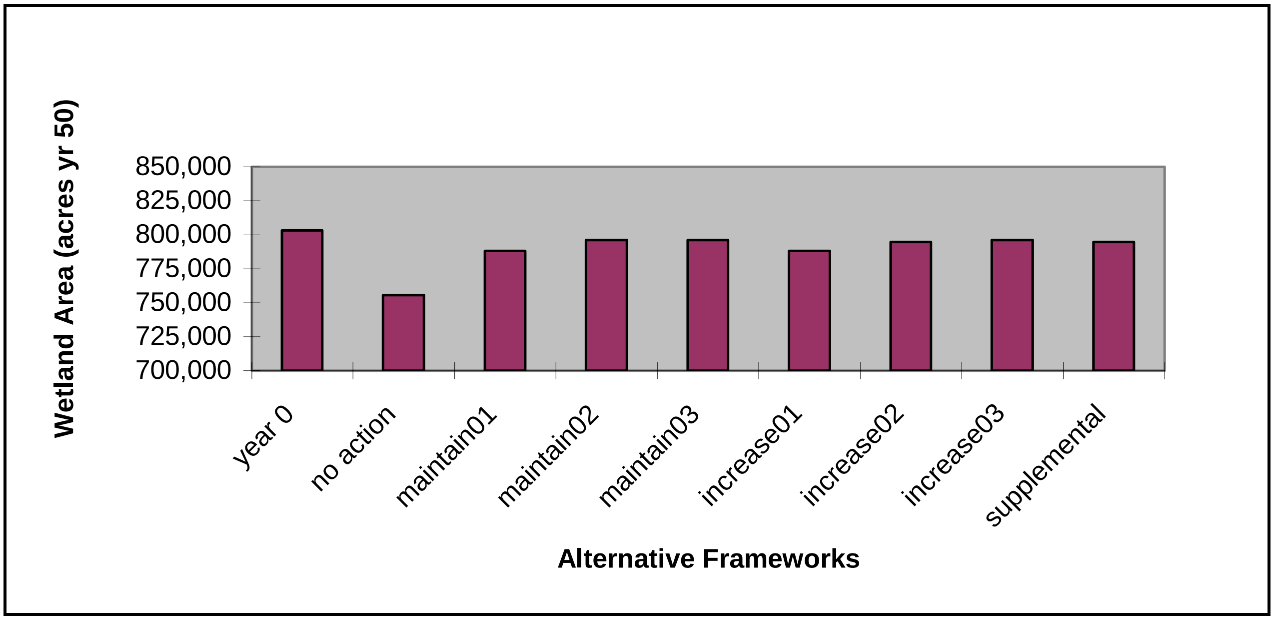


Figure E-19. Land Building at Year 50 for Subprovince 4 Alternatives.

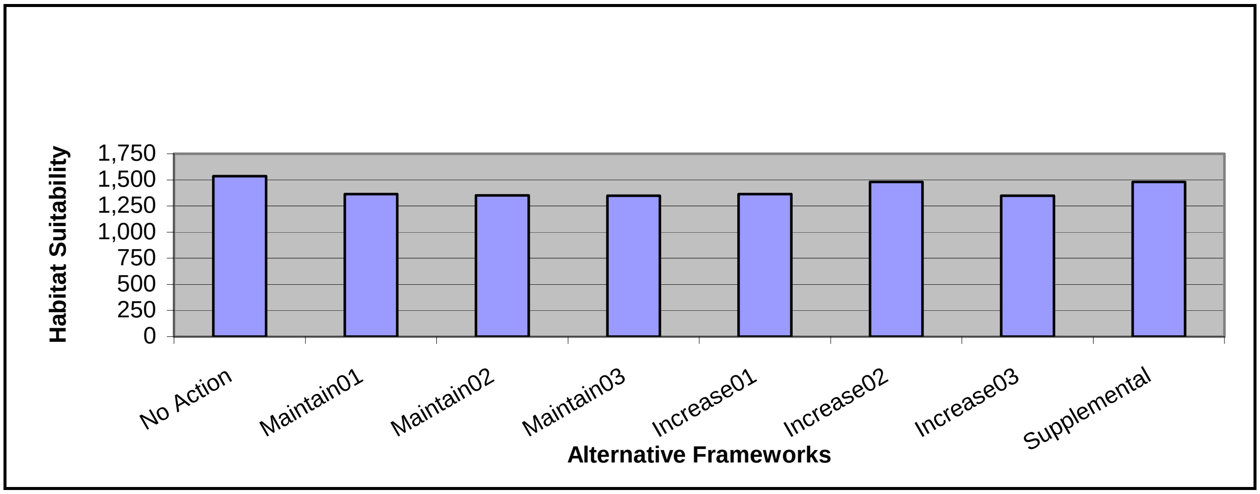


Figure E-20. Habitat Suitability for Lower Salinity Species at Year 50 for Subprovince 4.

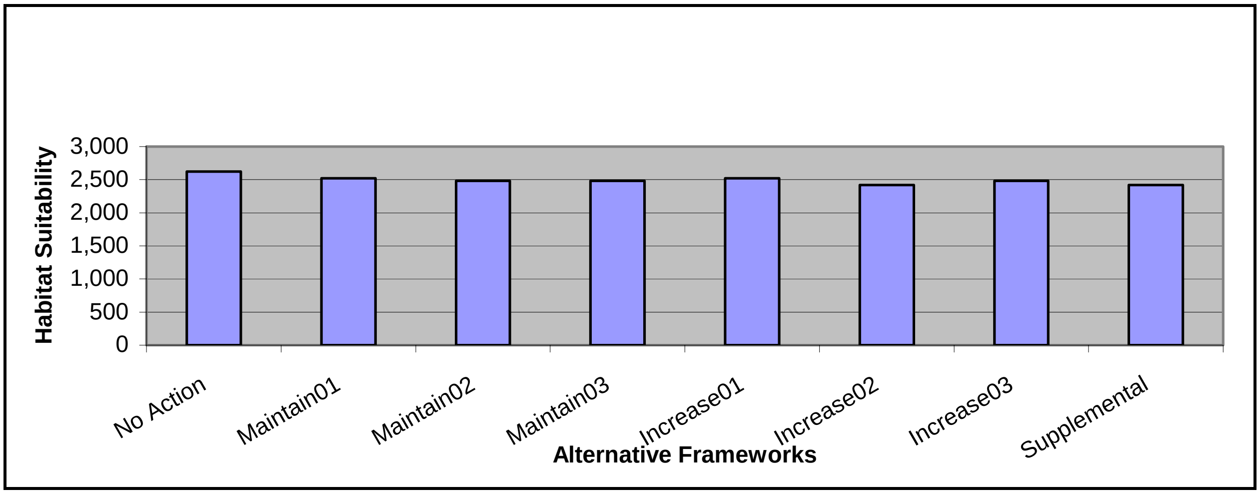


Figure E-21. Habitat Suitability for Moderate Salinity Species at Year 50 for Subprovince 4.

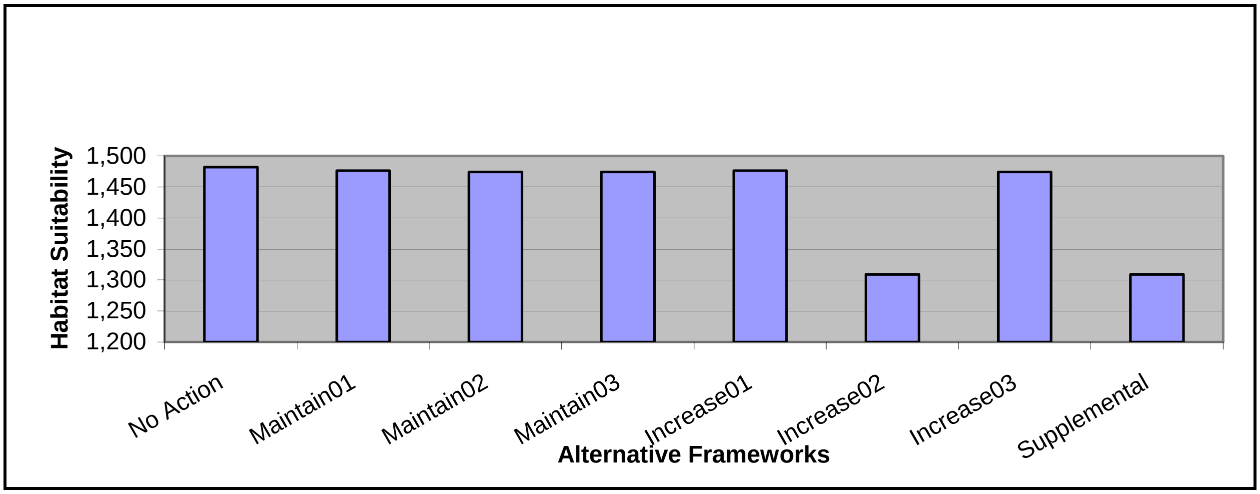


Figure E-22. Habitat suitability for Higher Salinity Species at Year 50 for Subprovince 4.

Table E-18.
Percent Habitat Composition at Year 50 for Subprovince 4 Alternatives.

	Brackish Marsh	Fresh Marsh	Intermediate Marsh	Saline Marsh	Swamp	Upland	Water
No Action	14.8	22.9	17.4	0.0	0.2	11.5	33.2
Maintain 1	14.9	20.3	22.3	0.0	0.2	11.5	30.9
Maintain 2	15.2	20.4	22.4	0.0	0.2	11.5	30.3
Maintain 3	15.3	20.4	22.4	0.0	0.2	11.5	30.3
Increase 1	14.9	20.3	22.3	0.0	0.2	11.5	30.9
Increase 2	11.4	23.9	22.7	0.0	0.2	11.5	30.4
Increase 3	15.3	20.4	22.4	0.0	0.2	11.5	30.3
Supplemental	11.4	23.9	22.7	0.0	0.2	11.5	30.4

Table E-19.
Total Production of Vegetation with the Subprovince 4 Alternatives (km^2 production units).

	Year 00	Year 10	Year 20	Year 30	Year 40	Year 50
No Action	1,507.2	1,558.4	1,552.1	1,521.0	1,494.8	1,470.8
Maintain 1	1,507.2	1,522.8	1,514.4	1,483.9	1,457.3	1,433.5
Maintain 2	1,507.2	1,516.8	1,510.3	1,480.3	1,453.8	1,430.0
Maintain 3	1,507.2	1,517.1	1,510.6	1,481.6	1,454.1	1,430.3
Increase 1	1,507.2	1,533.8	1,514.4	1,483.9	1,457.3	1,433.5
Increase 2	1,507.2	1,531.7	1,527.8	1,497.7	1,471.7	1,448.4
Increase 3	1,507.2	1,517.1	1,510.6	1,480.6	1,454.1	1,430.3
Supplemental	1,507.2	1,531.7	1,527.8	1,497.7	1,471.7	1,448.4

Table E-20.
Cumulative Habitat Suitability of Subprovince 4 Alternatives at Year 50.

	No Action	Maintain 01	Maintain 02	Maintain 03	Increase 01	Increase 02	Increase 03	Supplemental
bass	13,787.9	11,446.0	11,446.0	11,446.0	11,446.0	13,663.3	11,446.0	13,663.3
croaker	13,791.7	13,350.9	13,212.7	13,213.5	13,350.9	13,212.7	13,213.5	13,212.7
trout	10,337.0	12,173.1	11,986.5	11,986.5	12,173.1	9,491.4	11,986.5	9,491.4
menhaden	15,631.9	15,357.1	15,175.5	15,180.6	15,357.1	14,726.7	15,180.6	14,726.7
brown shrimp	12,866.3	12,049.6	11,929.9	11,940.7	12,049.6	11,990.1	11,940.7	11,990.1
white shrimp	17,794.6	17,547.7	17,321.7	17,321.7	17,547.7	16,893.0	17,321.7	16,893.0
oyster	2,422.5	1,801.7	2,222.4	2,227.1	1,801.7	2,168.8	2,227.1	2,168.8
mink	6,492.3	6,259.2	6,214.5	6,214.0	6,259.2	6,322.8	6,214.0	6,322.8
otter	7,111.4	6,943.0	6,899.5	6,895.7	6,943.0	7,116.9	6,895.7	7,116.9
muskrat	13,583.0	13,397.5	13,405.1	13,417.7	13,397.5	12,871.5	13,417.7	12,871.5
alligator	8,435.9	8,266.2	8,150.2	8,147.4	8,266.2	8,326.1	8,147.4	8,326.1
duck	7,444.1	6,917.8	6,845.6	6,845.4	6,917.8	7,073.8	6,845.4	7,073.8

6.5 Cost Effectiveness/Incremental Analysis

6.5.1 Overview

This study evaluated several frameworks designed to preserve coastal habitat and functions now recognized as a vital national resource. The intent is to save these important resources in a manner that also sustains or increases other economic resources that are the traditional focus of the Federal water resource program. The benefits of the various frameworks are defined in non-monetary units, as previously described. Benefits for most of the study area are evaluated using a qualitative and quantitative metric that assesses each alternative's contribution to the stock of natural resources. In the Chenier Plain portion of the study area, benefits are measured more simply in acres of land preserved or restored. Since these features are not readily translatable to dollar terms, traditional benefit-cost analysis is not possible. Consequently, a method that allows the comparison of benefits measured in these metrics mentioned above and costs measured in dollars was performed and is referred to herein as CE/ICA.

6.5.2 Methodology

A number of restoration frameworks were developed for various portions of the coastal area. Individual sets of frameworks were evaluated on their own and as possible combinations. In forming these combinations, three types of interactions were taken into account: exclusions, dependencies, and synergistic effects.

In several instances, many of the proposed frameworks could not be combined (i.e., they are mutually exclusive). In some cases, the exclusion exists because the alternatives occupy the same space. For example, more than one flow regime may be evaluated at the same location. In other cases, some alternatives cannot function without other frameworks in place, i.e., they are dependent on other frameworks. Likewise, synergistic features may produce more or less benefit when combined with other frameworks. Each type of interaction was addressed during the evaluation of alternatives.

The costs and benefits of the frameworks were amortized over a 50-year period of analysis at the current Federal discount rate of 5.875 percent. Costs were estimated at the October 2003 price level. Engineering and design, and supervision and administration costs were not available when the cost-effectiveness analysis was completed. However, since these charges are a fixed percentage of construction costs for all alternatives and the projects have similar construction schedules, their inclusion would be unlikely to influence project selection, i.e., the relative ranking of projects should be unaffected by the omission. The only consequential effect is a fairly uniform understatement of the cost of all alternatives.

6.5.3 Cost Effectiveness Assessment

In the cost-effectiveness analysis, the coastwide frameworks were assessed according to their ability to produce output for a given cost level. The frameworks that maximized output per dollar spent were retained, while those alternatives that did not were eliminated. The result was a listing of frameworks that would achieve each output level at the lowest cost, or an "efficient frontier." Restated, alternative frameworks screened in this manner met these two tests: (1) no other solution produces the same output for less cost, and (2) no other solution provides more output for the same or less cost.

The cost-effectiveness assessment was followed by an incremental cost analysis. Incremental cost is the additional cost for each increase in the level of output. Changes in incremental costs, combined with other selection criteria discussed below, facilitated a process of evaluating the desirability of implementing the remaining frameworks in the absence of a strict guideline for determining the best outcome (such as maximizing net benefits, as is done in national economic development analysis). Potential economic impacts of the plans were roughly estimated and taken into consideration in project selection as follows: after CE/ICA, both positive and negative economic impacts of in the final array were estimated on a gross basis to inform decision makers of the magnitude of these effects.

6.5.4 Ecosystem Benefits (B2) Assessment

To generate benefit values for input to the cost-effectiveness analysis, one benefit number has been developed, termed "B2." This benefit number will indicate how well a particular alternative meets Ecosystem Objectives, and will indicate the alternative's effectiveness in creating or preserving land. This benefit protocol incorporates measurements of the quality and quantity of land created or preserved, as well as the capacity of each framework to remove nitrogen from river water before it reaches the gulf (see the Ecological Modeling Appendix, C, for further details).

6.5.5 Methodological Uncertainties

Readers should be aware of several important limitations to the data and methodology used herein. These limitations impacted the outcome of the analysis, and were considered when using the results for planning purposes. These limitations concern the benefits calculations, implementation costs, and NED impacts of the alternatives.

6.5.5.1 Benefits projections

This benefit protocol incorporates measurements of three variables: the quality of habitat produced, the quantity of land created or preserved, and the capacity of each framework to remove nitrogen from river water before it reaches the gulf. The outputs produced for each of these scaled benefit types were quantified for each alternative, and weights were assigned to establish the relative value of each of these three outputs. A consensus of professional judgment was used to determine the weighting of these benefit types, and an estimate of the composite factor B2 was produced for each feature. The weights are critical to the outcome of the analysis, i.e., the results could change greatly if the weighting factors were different.

As a procedural matter, since the weighting of scaled benefits was incorporated into the calculation of the B2 variable itself, B2 units were put directly into the computer program that was used to develop cost-effective frameworks. An alternate method would have been to put features of the benefit types directly into the program and place weighting factors on each of these outputs. The two methods would yield similar results.

The benefits model produced fairly small differentials in output for many alternative frameworks, and these small differentials may be beyond the capability of the modelers to predict with great certainty. Yet, the model differentiates between alternative frameworks with small benefit differences. For example, Alternative framework 7000 is predicted to produce 1,945 average annual benefit units per year. The next cost-effective alternative framework, 5010, would produce 1,987 units per year, a change of 42 units, or about 2 percent. Given the highly experimental nature of the benefits model, these frameworks may well be considered equal. Moreover, displaying the figures in this manner risks creating a false sense of precision in the process.

In addition, the reader should be aware that there also limitations noted regarding the calculation of the input values of quality of habitat, quantity of land, and nitrogen removal; each of these required inputs to the B2 protocol. Overall, these limitations mean that alternatives that contain large diversion features may have more uncertain estimates of land building, may underestimate nitrogen removal, and may overstate impacts to higher salinity habitats. The limitations to measurement of these three variables are outline below.

> *Quality of Habitat.* Assessment of habitat quality includes estimates of habitat suitability for selected fish and wildlife species that use the estuary. Appendix C "Ecological Modeling: Louisiana Coastal Area Ecosystem Model" note that the box models used to estimate salinity changes across subprovinces mask salinity gradients within a box. Some of the species (birds, mammals, reptiles) respond more to the vegetated community type, while others (fish, shrimp, oysters) respond to changes in salinity along the estuarine gradient. This means that some species are more sensitive to abrupt changes in the salinity gradient due to model limitations. Habitat for species, which use higher salinity areas of the estuary, is thus likely underestimated, while moderate salinity habitat is probably over estimated. The assessment of habitat quality included in B2 includes categories for habitats in low, moderate, and higher salinity environments. To some extent the uncertainties in habitat suitability predictions may counteract one another, but it is likely that B2 values for framework including very large diversions are more uncertain than for others.
>
> *Quantity of Land*. The features encompassed by the alternatives include very large diversions and small diversions, as well as mechanical marsh creation. As noted in the Ecological Modeling appendix, there are limitations to the land building and nourishment desktop models that will affect all sizes of diversions. In addition, they note that estimates of land building by mechanical means, such as using dredging or sediment conveyance by pipeline, are likely to be more accurate. However, it is unclear that these limitations should prejudice any broad scale consideration of the land building estimates for the subprovince alternatives. These limitations do, however, mean that relatively small differences in land building among frameworks are likely less important than overall trends.

Nitrogen Removal. The uncertainties in modeling identified by Appendix C "Hydrodynamic and Ecological Modeling: Louisiana Coastal Area Ecosystem Model" suggest that the nutrient reduction potential of very large river diversions is likely underestimated in the analyses presented here. They also note that there may be some, but much smaller in absolute magnitude, overestimates for smaller diversions.

6.5.5.2 Cost estimates

Cost estimates produced an accuracy level somewhat below that of a normal feasibility study. To the degree that these costs are misstated, the accuracy of the analysis is compromised.

6.5.6 Framework Analysis Results

The results of the CE/ICA analysis are presented below. Results for the Deltaic Plain are discussed together while the Chenier Plan was analyzed separately. A predominant selection criterion was the availability of river resources. Due to differences among habitat types and physical constraints, the study area was divided into two main areas for this assessment. The first area is an assembly of the Deltaic Plain, a series of alluvial plains. These areas were originally produced by the Mississippi River and its tributaries as these water bodies changed course over time. The preservation of these plains will depend on the same river system. Hence, achievement of any of these goals is constrained by the amount of water available in the river and tributary system. The Chenier Plain, in contrast, is not created by river water, and the creation and preservation of habitat in this area is not constrained by available river resources. Thus potential solutions for the Deltaic Plain are interdependent and should be considered together, while the Chenier Plain may be evaluated independently.

6.5.7 Initial Deltaic Plain Results

The first cost-effectiveness analysis examined combinations of alternatives that were developed for Deltaic Plain. These primarily consisted of river diversions of various sizes. Since most of these alternatives use significant amounts of river water, the optimization of the alternatives was done using a constraint on the total amount of water drawn from the river. The constraint was that the total amount of water drawn from the river was limited to 45 percent of the river's average flow based on diversion percentage data developed for each framework for conditions in the month of June.

Figure E-23 below provides an overview of the CE/ICA process used to evaluate the frameworks for the Deltaic Plain.

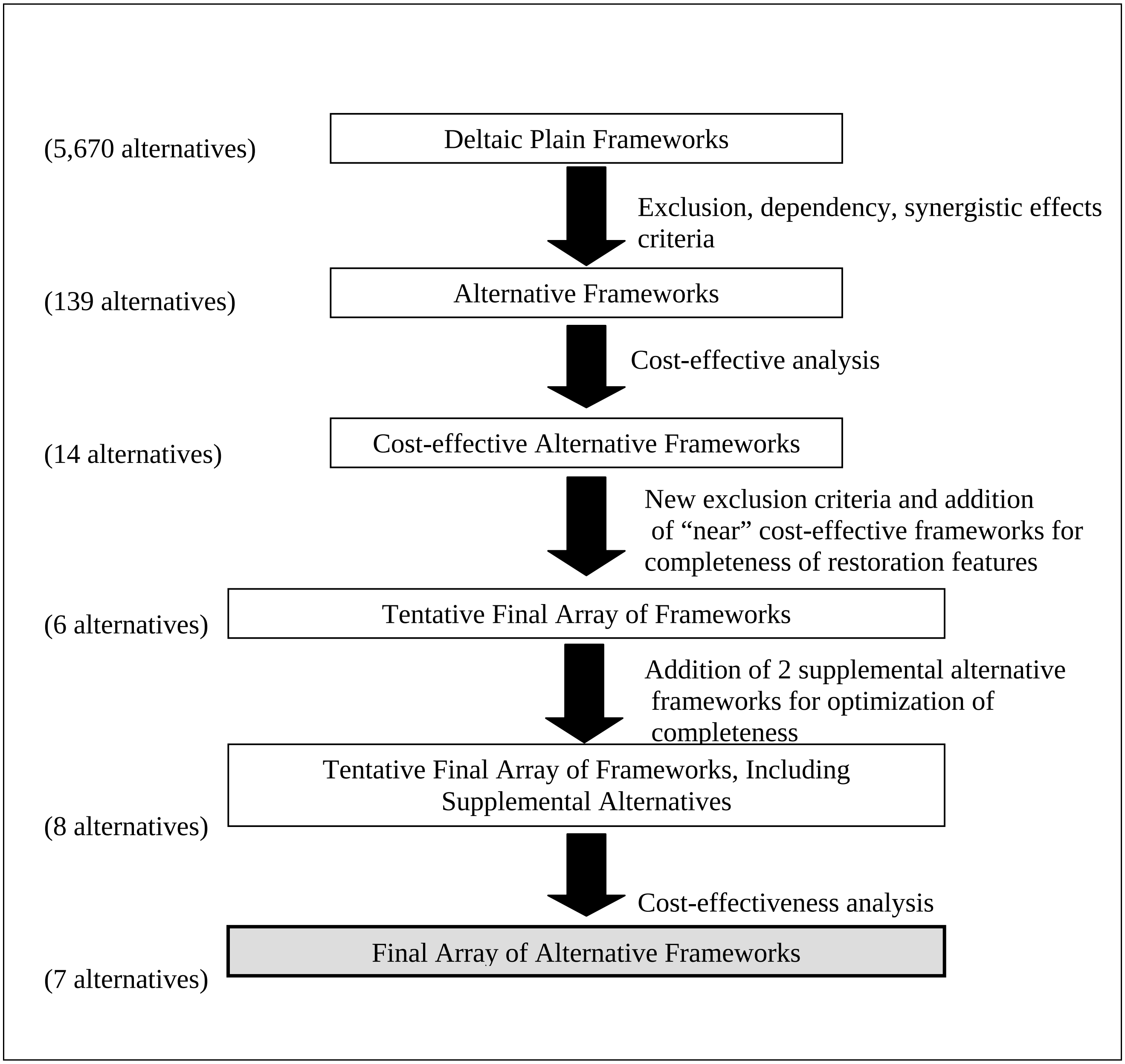


Figure E-23. Cost-Effectiveness and Incremental Cost Analysis Process, Deltaic Plain.

The analysis initially produced 5,670 combinations of alternatives, of which 139 were possibilities after considering exclusions, dependencies, and the water constraints. Of these alternatives, 14 were determined to be cost-effective. The graph below shows the results of the cost-effectiveness analysis (**figure E-24**). All alternative frameworks are shown on the graph, with the cost-effective alternatives (the efficient frontier) highlighted. The small numbers next to each point are framework identifiers used throughout this report. The same identifiers are also used in the accompanying tables.

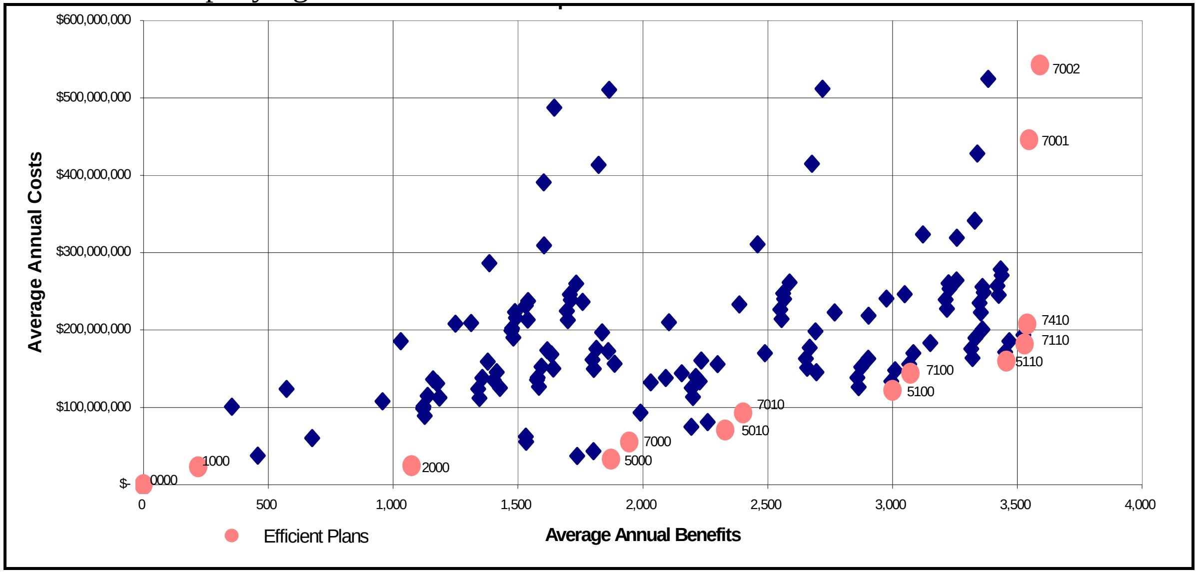


Figure E-24. Average Annual Costs and Average Annual Benefits for Each of the Alternative Frameworks Generated by IWR-Plan for the Deltaic Plain.

The identifiers indicate the alternative associated with Subprovinces 1-3 (**table E-21**). The first digit of the identifier identifies the alternative for Subprovince 1. The second digit identifies the alternative for Subprovince 2. The third digit identifies the alternative for Subprovince 3. Finally, the fourth digit identifies the alternative choice for the Third Delta Project. For example: Framework 7620 would translate to Subprovince 1, E1; Subprovince 2, M3; Subprovince 3, R3; and no Third Delta alternative. Descriptions of each Subprovince alternatives and its corresponding features can be found in Attachment 1. The incremental cost analysis results for the 14 cost-effective alternative frameworks for Subprovinces 1-3 are illustrated in **table E-21**.

Table E-21.
Key to Alternative Framework Identifiers.

Identifier	0	1	2	3	4	5	6	7	8	9	10
Subprovince 1 (First Digit)	NA	R1	R2	R3	M1	M2	M3	E1	E2	E3	N1
Subprovince 2 (Second Digit)	NA	R1	R2	R3	M1	M2	M3	E1	E2	N1	
Subprovince 3 (Third Digit)	NA	R1	R3	N1							
Third Delta (Fourth Digit)	NA	SP 2, E3 and SP 3, R2	SP 2, E3 and SP 3, M1								

Where: SP = Subprovince, NA = No Action, R= Reduce, M= Maintain, E= Increase, N = Supplemental

Table E-22.
Costs and Benefits for the Cost-Effective Alternative Frameworks for the Deltaic Plain.

Framework	Average Annual Benefits	Average Annual Costs ($)	Cost per Unit ($)	Incremental Cost
0	0	0	0	0
1000	219	22,910,914	104,616	104,616
2000	1,074	24,350,598	22,673	1,684
5000	1,873	32,838,902	17,533	10,624
7000	1,945	55,021,432	28,289	308,091
5010	2,330	70,438,353	30,231	40,044
7010	2,402	92,620,883	38,560	308,091
5100	3,000	122,043,563	40,681	49,202
7100	3,072	144,226,093	46,949	308,091
5110	3,457	159,643,014	46,180	40,044
7110	3,529	181,825,544	51,523	308,091
7410	3,540	207,599,025	58,644	2,343,044
7001	3,548	445,780,195	125,643	29,772,646
7002	3,591	542,511,742	151,075	2,249,571

* *Benefits measured using the B2 Protocol, as explained in the text. Shaded lines indicate frameworks that were carried forward to the analysis step – the development of a tentative final array of alternatives.*

6.5.8 Development of the Tentative Final Array for the Deltaic Plain

Following an initial CE/ICA analysis, the alternative framework process continued by applying four additional criteria to cost-effective coastwide alternative frameworks. The four criteria are as follows:

1. Alternative frameworks that cost approximately $60 million per year to implement were eliminated from further consideration because the existing CWPPRA was already available for implementing such alternatives. The intent of the LCA effort is to focus on larger-scaled projects that are beyond the current scope of CWPPRA.

2. Alternative frameworks were limited to those that reduced land loss by at least one half of the current rate (based on 1990-2000 landloss data of –24 mi^2/yr to-10 mi^2/yr [-62 km^2/yr to –26 km^2/yr]).

3. Alternative frameworks were evaluated for their potential to provide storm surge protection across the coast (i.e., in all Subprovinces), as well as for their potential to impact the navigation industry.

4. Alternative frameworks were assessed for their potential to add environmentally significant features, such as barrier islands or a Third Delta feature, in subsequent implementation phases.

During this stage of the alternative framework selection process, the PDT evaluated the alternative frameworks that formed the cost-effective frontier and eliminated several of the frameworks from further consideration. Some cost-effective alternative frameworks were eliminated because they did not provide potential coastwide restoration or economic damage reduction. Other cost-effective alternative frameworks that met these criteria occurred at approximately the point in the cost-effective curve at which the cost per unit benefit begins to rise rapidly. These frameworks were 5110, 7110, and 7410. Framework 7002 represented the terminal point of the cost-effective frontier. Based on the criteria of cost-effectiveness, exceeding minimum program and output values, and providing maximum potential damage reduction, framework 5110 (made up of S1M2, S2R1, and S3R1) would be a rational framework selection. However, upon review of these frameworks, the PDT identified several environmentally significant features that were not included in or addressed by this or any of the cost-effective frameworks.

It was determined that additional alternative frameworks near the cost-effective curve, particularly near the point of rapidly increasing unit cost, could fall within the limits of confidence. In addition, these alternative frameworks would provide more completeness to a final array of restoration solutions. Beginning at the previously identified location on the cost-effective curve, the PDT used the IWR-Plan software and began investigating additional alternative frameworks adjacent to the cost-effective frontier that included significant features not in the cost-effective alternative framework combinations. A number of additional frameworks were identified that addressed the identified significant features such as the barrier islands in Subprovince 3. These included frameworks 5610, 5410, 7610, 5120, 5620, 5710, and 7120. These frameworks were grouped with the remaining 3 cost-effective frameworks to form a tentative final array (**table E-23**). In addition, one cost-effective framework, framework number 7110, appeared to be redundant in its composition but more costly and was not considered by the PDT in the tentative final array.

Table E-23.
Benefits and Costs for Tentative Final Array of Frameworks for the Deltaic Plain.

Framework	Average Annual Benefits	Average Annual Costs ($)	Cost per Unit ($)
5620	3349	234,801,138	70,111
5120	3354	222,964,398	66,477
5710	3361	255,291,778	75,957
7120	3426	319,243,162	93,182
5610	3452	171,479,754	49,675
5110	3457	159,643,014	46,180
5410	3468	185,416,495	53,465
7610	3524	193,662,284	54,955
7410	3540	209,000,000	59,040
7002	3591	542,511,742	151,075

* *Benefits measured using the B2 Protocol, as explained in the text. Shaded lines indicate cost-effective frameworks that were included the tentative final array*.

The following graphs (**figures E-25 and E-26**) illustrate the relationships among the cost-effective frameworks and the additional alternatives in the tentative final array. **Figure E-28** is cropped to depict only the cost-effective and additional alternative frameworks included in the tentative final array. Note that several of the additional frameworks are fairly close to the efficient frontier, and, given the limitations of the benefit data, are within the reasonable limits of confidence for the efficient frontier.

Other frameworks appear to depart from the curve significantly in both cost and benefit. The most notable exception is Framework 7120, which is well above the efficient frontier. While there are also limits in the confidence of the cost data, these limits are not as significant as they are for the benefit data. As a result, these frameworks were determined to be significantly more costly per habitat unit produced in comparison to the other alternatives available that provided the same restoration benefit. Thus, frameworks 5120, 5620, 5710, and 7120 were dropped from further consideration.

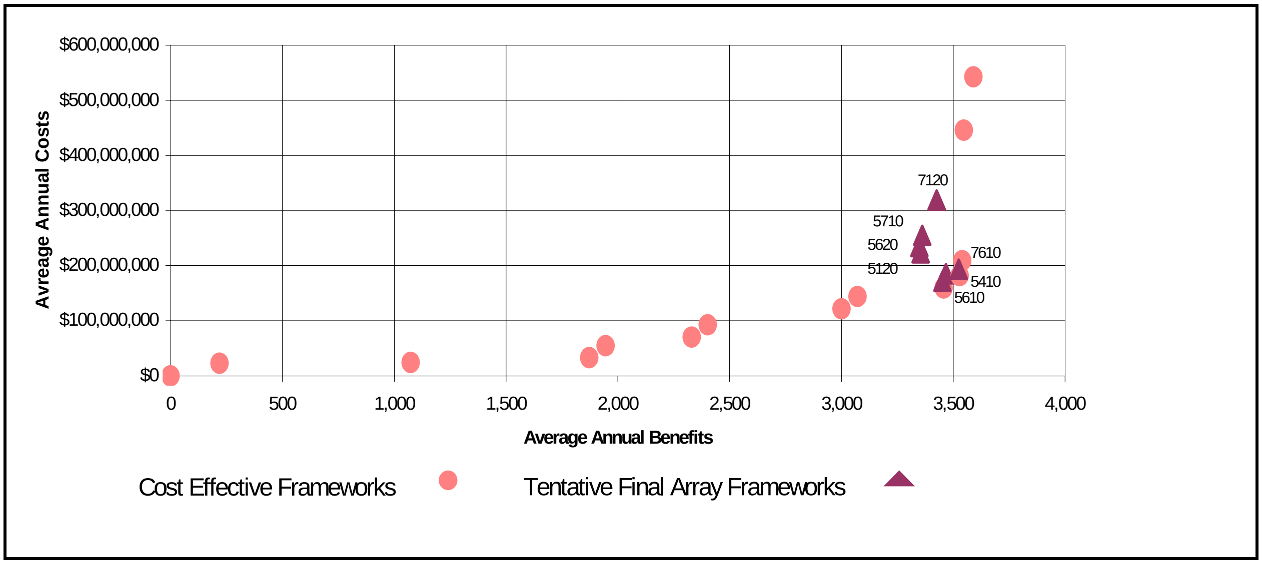


Figure E-25. Costs and Benefits for the Cost-Effective and Tentative Final Array of Frameworks for the Deltaic Plain.

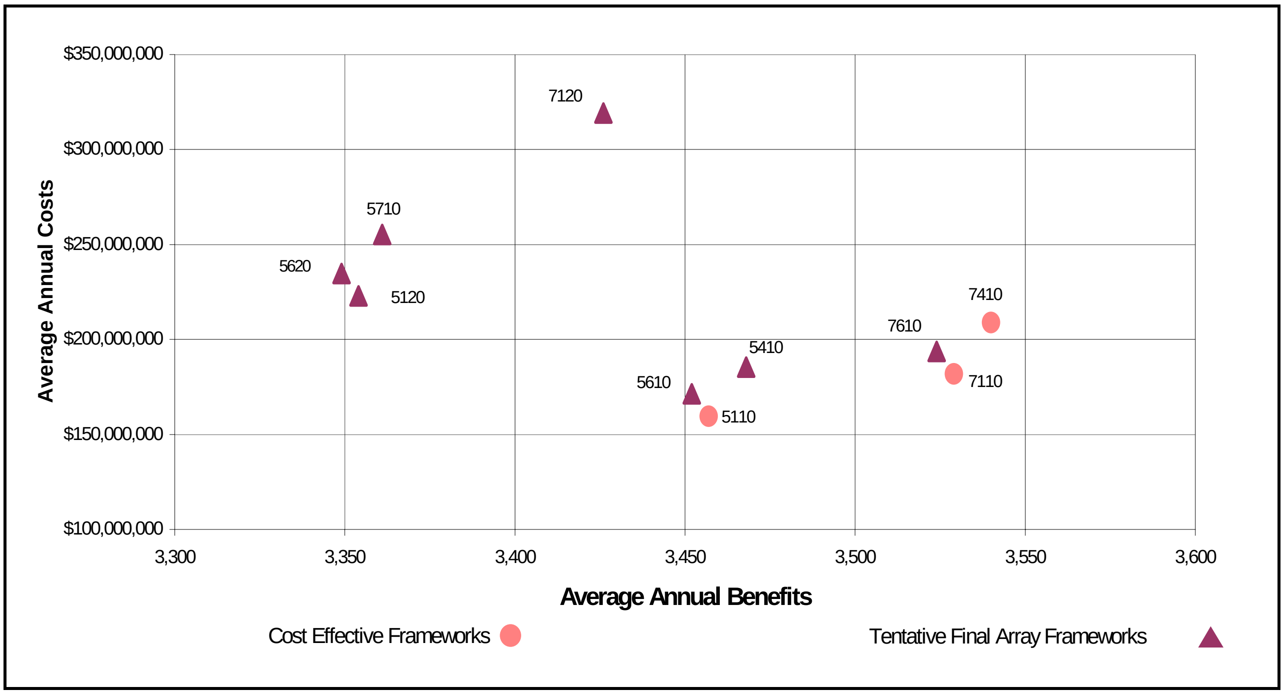


Figure E-26. Costs and Benefits for the Tentative Final Array of Frameworks of Interest for the Deltaic Plain (expanded view).

6.5.9 Development of Supplemental Frameworks to Address Completeness of Final Array

The executive team, vertical team, and individual members of the framework development team, reviewed the cost-effectiveness analysis and the PDT effort in developing the tentative final array. Following this review, the executive team directed the PDT to develop two supplemental frameworks to attempt to further address the criteria of environmentally significant features. These frameworks were also intended to address the completeness of the final array since the tentative frameworks identified by the initial analysis omitted a number of larger-scale features that were viewed as potentially critical to long-range success. The output from the ecological modeling and the experience gained from that effort provided valuable insight regarding framework effectiveness. The results of that effort were reviewed to determine what specific restoration features might be introduced to create a more complete and effective alternative framework.

The PDT reviewed the features, model outputs, and framework components for each subprovince. At the conclusion of this effort, the PDT had assembled the two supplemental alternative frameworks, which were loosely based on the alternative framework 5610. These two supplemental alternative frameworks were identical, except that one of the frameworks contained the Third Delta feature. Once the features of the supplemental alternative frameworks were identified, costs and benefits were developed for the supplemental alternatives in a manner consistent with the previously analyzed alternative frameworks (**table E-24**). These data were incorporated into the IWR-Plan database. A second iteration of the CE/ICA was run to determine the position of the two supplemental alternative frameworks relative to the cost-effective frontier.

Table E-24.
Benefits and Costs for Tentative Final Array with Supplemental Frameworks for the Deltaic Plain.

Framework	Average Annual Benefits	Average Annual Costs ($)	Cost per Unit ($)
5610	3,452	171,479,754	49,675
5110	3,457	159,643,014	46,180
5410	3,468	185,416,495	53,465
7610	3,524	193,662,284	54,955
7410	3,540	209,000,000	59,040
7002	3,591	542,511,742	151,075
A1	2,797	196,257,904	70,167
A2	3,321	405,580,519	122,126

* *Benefits measured using the B2 Protocol, as explained in the text. Shaded lines indicate cost-effective frameworks that were included the tentative final array*.

This analysis revealed that the basic supplemental framework was significantly above and to the left of the efficient frontier. The second supplemental framework was developed by simply combining the Third Delta feature with the basic supplemental framework. Neither framework plotted within the optimal range of the existing final array of alternative frameworks (**figure E-27**). A review of the features included in the second supplemental framework revealed that several of the diversion features could be redundant and potentially unimplementable with the inclusion of the Third Delta. Framework 7002 included several of the features identified for detailed investigation in the basic supplemental and include it as the supplemental framework along with framework 7002 in the final array.

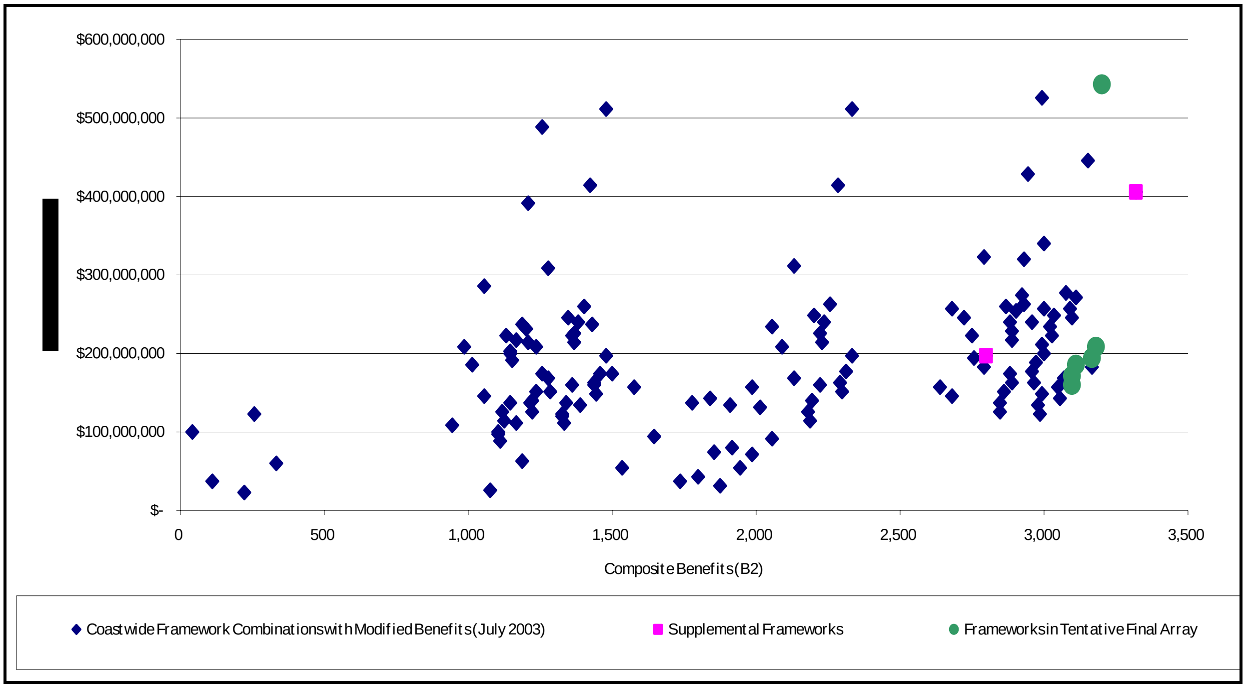


Figure E-27. Comparison of Supplemental Alternative Frameworks for the Deltaic Plain.

To further determine whether the combinable components of the supplemental framework had any specific strengths or weaknesses, another iteration of cost-effectiveness was executed for each subprovince. This analysis identified the strength (high B2 benefit value) of the supplemental framework in Subprovince 1 and its weakness (low B2 benefit value) in Subprovince 2. The supplemental alternative framework features were similar to existing components in Subprovinces 3 and 4. The results for Subprovince 4 are presented later in this section. Presented below is the relative efficiency of the supplemental framework components for each of Subprovinces 1, 2, and 3 (**figures E-28, E-29 and E-30**). The supplemental alternative framework features are labeled as N1 in each plot.

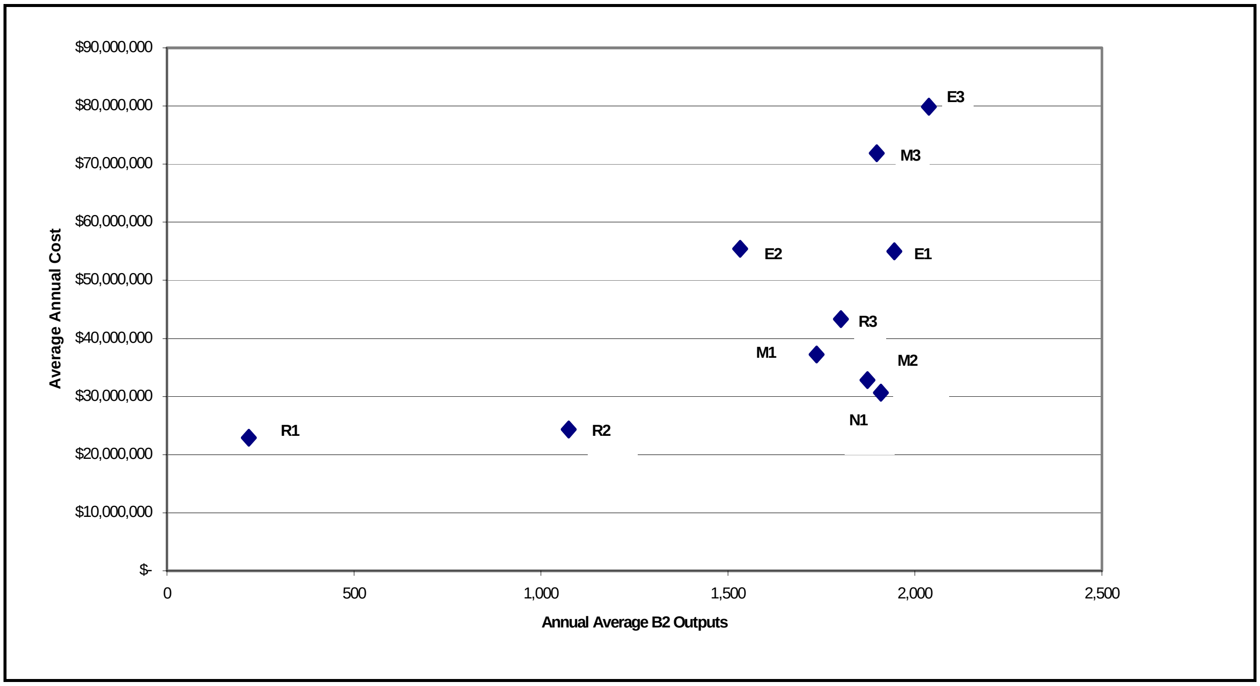


Figure E-28. Cost Effectiveness Graph of the Subprovince 1 Alternative Frameworks with Supplemental Framework (A-1).

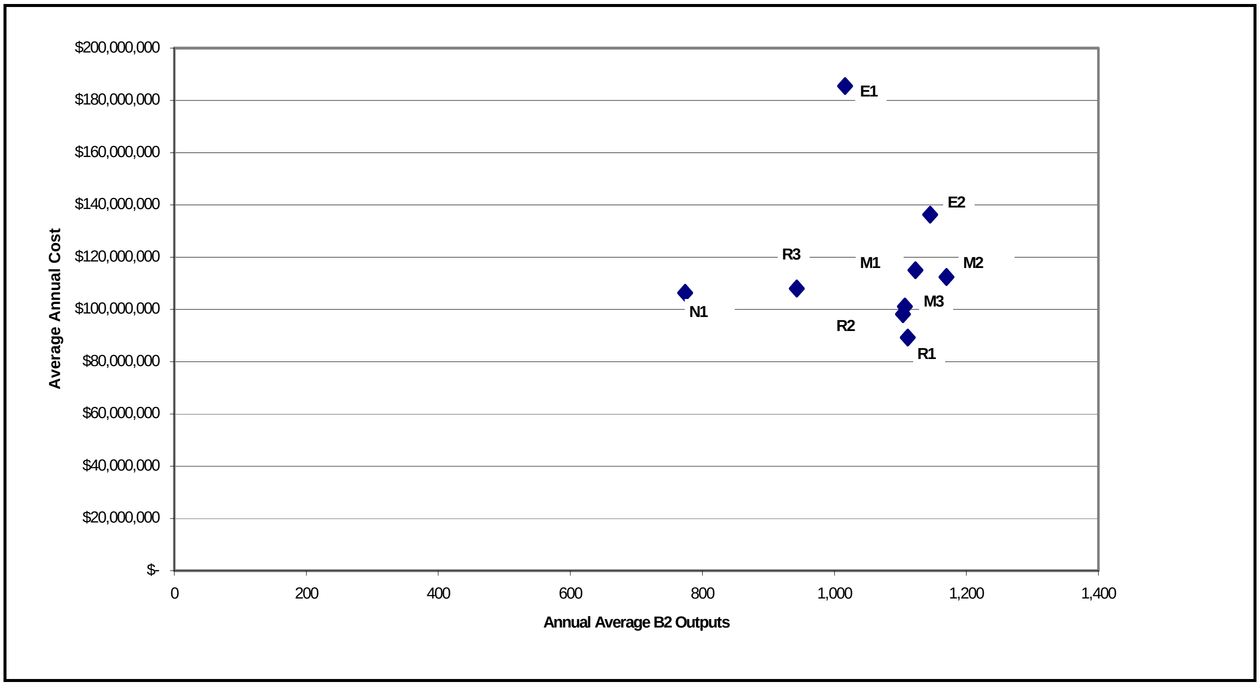


Figure E-29. Cost Effectiveness Graph of the Subprovince 2 Alternative Frameworks with Supplemental Framework (A-1).

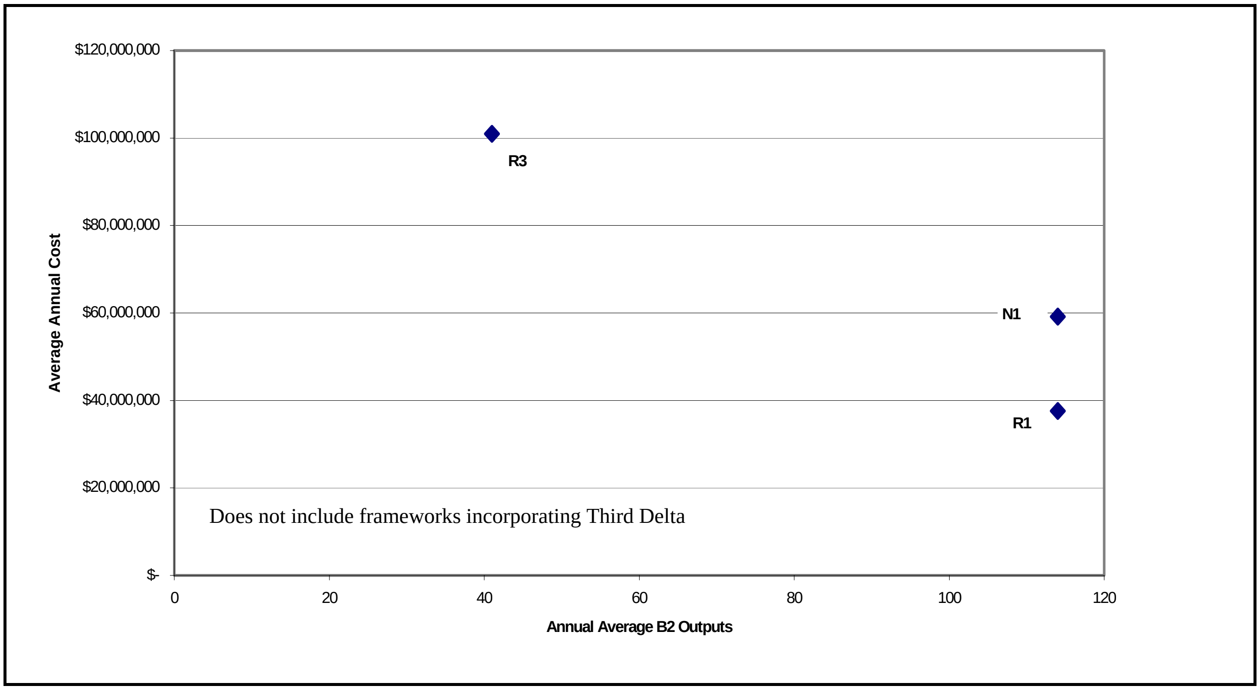


Figure E-30. Cost Effectiveness Graph of the Subprovince 3 Alternative Frameworks with Supplemental Framework (A-1).

The study executive team reviewed this information and was able to identify an existing alternative in Subprovince 2 that in combination with the other supplemental framework components in Subprovinces 1 and 3 could produce a modified supplemental framework that would enhance completeness and be cost-effective. The data for the modified supplemental framework, which was labeled 10130 (based on the IWR-Plan system of numbering solution scales), was added to the IWR-Plan database. An additional iteration of the cost-effectiveness analysis revealed the supplemental framework to be on the cost-effective curve and consistent with the position and criteria for the final array. The output for the final iteration of the CE/ICA is discussed below.

6.5.10 Final Iteration Results for the Deltaic Plain

All iterations of the analysis were performed in a manner consistent with the description of the initial cost-effectiveness analysis. Once again, the benefit units used for the analysis are described by the B2 protocol.

The analysis initially produced 25,920 combinations of frameworks, 152 of which were possible after considering exclusions, dependencies, and the total diversion constraint. It can be observed by comparing the initial and final analyses that the addition of even a small number of solutions or scales has an exponential effect on the number of possible combinations. Of these frameworks, 15 were determined to be cost-effective. The graph below (**figure E-31**) shows the results of the cost-effectiveness analysis. All 152 possible frameworks are shown on the graph, with the cost-effective frameworks (the efficient frontier) highlighted.

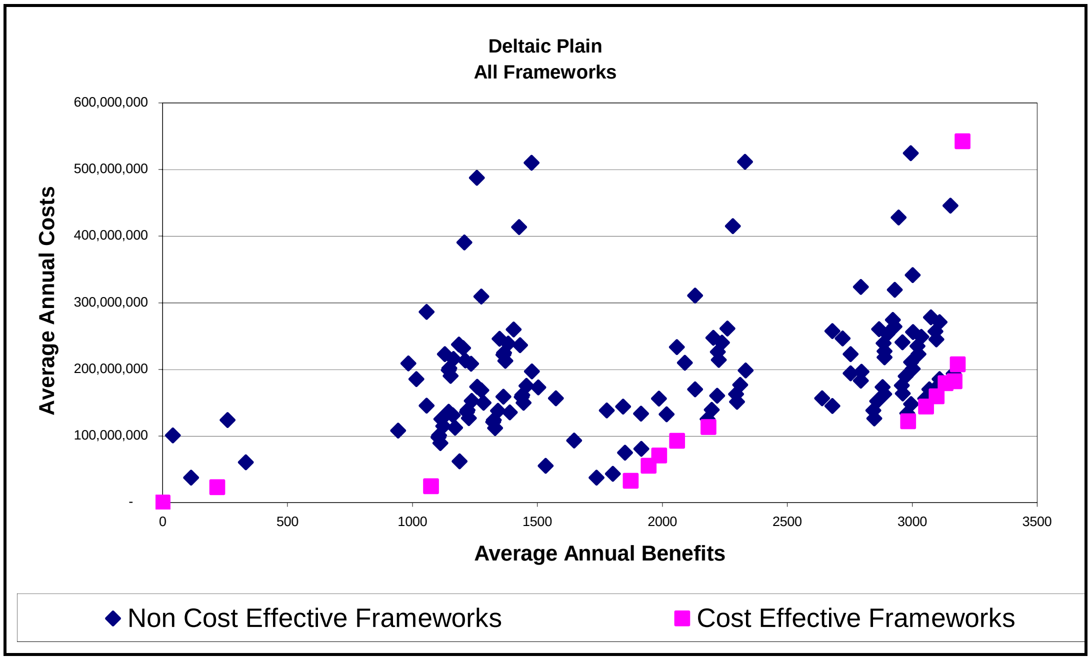


Figure E-31. Average Annual Costs and Average Annual Benefits for all Frameworks in the Cost-Effectiveness Analysis.

The incremental cost analysis results for the Deltaic Plain are illustrated in **table E-25** in ascending order of benefit performance. Only the cost effective frameworks are included in the table. The numbers in the first column of the table are codes for each framework that were generated by the program that was used to conduct the analysis. These identifiers are used throughout the report, and are placed next to the points used to represent each framework in the subsequent graphs. The second column shows a shorthand description of each framework. The number appearing after each "S" is the subprovince number. Alternatives designed to maintain the quantity or quality of habitat are labeled with an "M"; alternatives designed to increase habitat are labeled with an "E." Some frameworks are designed to preserve or increase habitat in the future at a level higher than in the future without-project condition, but at some level below existing conditions. These "reduced" alternatives are labeled "R." As an example, in row 3, Framework 2000 (S1R2) calls for Reduce Alternative 2 in Subprovince 1. The final array of alternatives, including the modified supplemental framework, is shown in the **table E-26**.

Table E-25.
Benefits and Costs for the Cost Effective Alternative Frameworks,
Including Supplemental Alternative Frameworks for the Deltaic Plain.

Framework Code	Framework Components	Average Annual Benefits 1/	Incremental Benefits 2/	Average Annual Costs 3/ ($)	Incremental Costs 4/ ($)	Incremental Cost per Unit 5/ ($)	Ave. Annual Cost/Ave. Annual Benefit ($)
0000	No Action	0		-		-	-
1000	S1R1	219	219	22,911,000	22,911,000	104,616	104,616
2000	S1R2	1074	855	24,351,000	1,440,000	1,684	22,673
5000	S1M2	1873	799	32,839,000	8,488,000	10,623	17,533
7000	S1E1	1945	72	55,021,000	22,182,000	308,083	28,288
5010	S1M2, S3R1	1987	42	70,438,000	15,417,000	367,071	35,449
7010	S1E1, S3R1	2059	72	92,621,000	22,183,000	308,097	44,983
2100	S1R2, S2R1	2185	126	113,555,000	20,934,000	166,143	51,970
5100	S1M2, S2R1	2984	799	122,044,000	8,489,000	10,625	40,899
7100	S1E1, S2R1	3056	72	144,226,000	22,182,000	308,083	47,194
5110	S1M2, S2R1, S3R1	3098	42	159,643,000	15,417,000	367,071	51,531
10130	S1N1, S2N1, S3N1	3134	36	179,074,000	19,431,000	539,750	57,139
7110	S1E1, S2R1, S3R1	3170	36	181,826,000	2,752,000	76,444	57,358
7410	S1E1, S2M1, S3R1	3182	12	207,599,000	25,773,000	2,147,750	65,242
7002	S1E1, S2E3, S3M1	3202	20	542,512,000	334,913,000	16,745,650	169,429

1/ Benefits featured using the B2 Protocol, as explained in the text.
2/ Incremental benefits are the benefits of each framework less the benefits of the framework with the next lower cost.
3/ Average annual costs are the implementation costs annualized over 50 years.
4/ Incremental costs are the costs of each framework less the costs of the next lower cost framework.
5/ Incremental costs per unit are the incremental costs divided by the incremental units of output provided by each framework. Shaded lines indicate frameworks that were carried forward to the final array.

Table E-26.
The Final Array of Frameworks for the Deltaic Plain, Including Supplemental Alternative Frameworks.

Framework Code	Framework Components	Average Annual Benefits 1/	Incremental Benefits 2/	Average Annual Costs 3/ ($)	Incremental Costs 4/ ($)	Incremental Cost per Unit 5/ ($)	Ave. Annual Cost/Ave. Annual Benefit ($)
0000	No Action	0		-		-	-
5610	S1M2, S2M3, S3R1	3094	3094	171,480,000	171,480,000	55,423	55,423
5110	S1M2, S2R1, S3R1	3098	4	159,643,000	(11,837,000)	(2,959,250)	51,531
5410	S1M2, S2M1, S3R1	3110	12	185,416,000	25,773,000	2,147,750	59,619
10130	S1N1, S2N1, S3N1	3134	24	179,074,000	(6,342,000)	(264,250)	57,139
7610	S1E1, S2M3, S3R1	3166	32	193,662,000	14,588,000	455,875	61,169
7410	S1E1, S2M1, S3R1	3182	16	207,599,000	13,937,000	871,063	65,242
7002	S1E1, S2E3, S3M1	3202	20	542,512,000	334,913,000	16,745,650	169,429

1/ Benefits featured using the B2 Protocol, as explained in the text.
2/ Incremental benefits are the benefits of each framework less the benefits of the framework with the next lower cost.
3/ Average annual costs are the implementation costs annualized over 50 years.
4/ Incremental costs are the costs of each framework less the costs of the next lower cost framework.
5/ Incremental costs per unit are the incremental costs divided by the incremental units of output provided by each framework. Shaded lines indicate frameworks that were carried forward to the final array.

The following graph (**figure E-32**) illustrates the relationships of the final array of coastwide alternative frameworks to all other frameworks considered. The graph depicts only the cost-effective and supplemental alternative frameworks that are discussed in detail in the main report section on framework formulation. The results of the final iteration of cost-effectiveness illustrated that the alternative frameworks identified in the tentative final array remained consistent in their position relative to the efficient frontier. The inclusion of the supplemental alternative framework (10130) in this iteration of the analysis resulted in the addition of this alternative framework to the efficient frontier.

The alternative frameworks are all fairly close to the efficient frontier, and, given limitations of both the benefit and cost data, are within the margin of error for the efficient frontier. That is, given the level of accuracy in the model's prediction of benefits and limitations on our ability to estimate costs, it is not possible to state with certainty that the supplemental alternative framework that was considered is less efficient than those on the efficient frontier. The exception, since the framework that produces the maximum possible output is always a component of the efficient frontier, is framework 7002. This framework has costs far in excess of frameworks which produce only slightly lower benefit levels, as illustrated in the graph below.

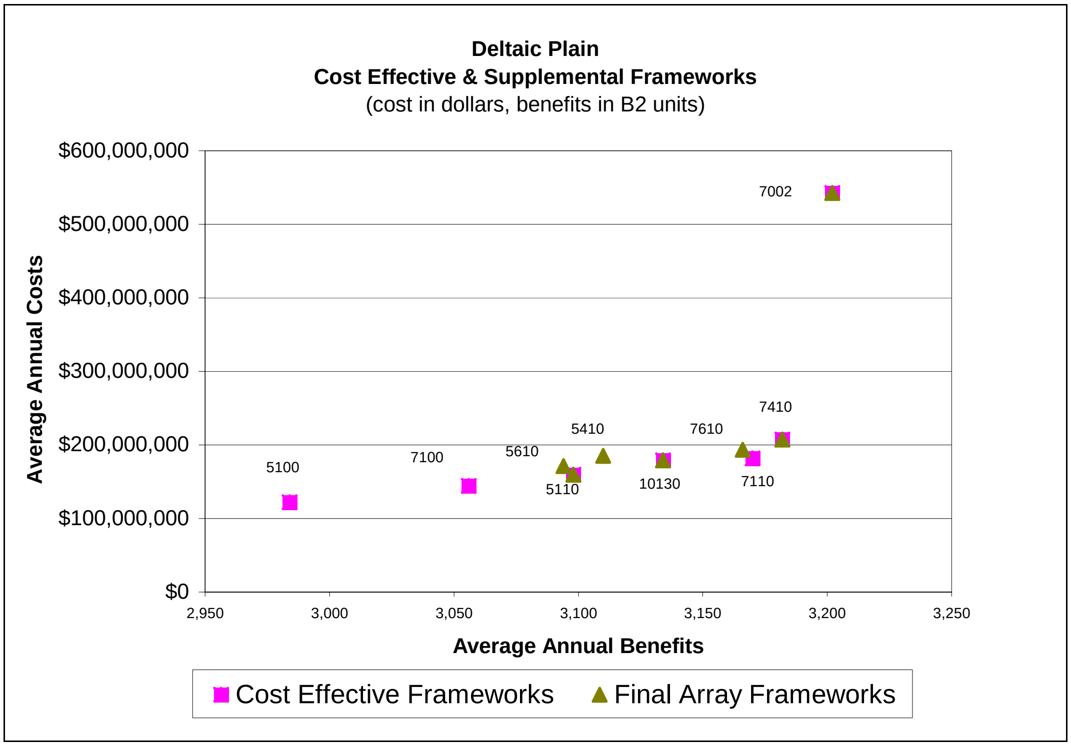


Figure E-32. Average Annual Costs and Average Annual Benefits for the Final Array of Frameworks for the Deltaic Plain.

The bar graph below also illustrates the relationships of benefits and costs for the array of frameworks (**figure E-33**). Benefits are expressed in average annual benefit units (B2), while average annual costs are shown in hundreds of thousands of dollars. The graph indicates that the level of benefits does not greatly vary for the array of alternative frameworks. As previously stated, this is especially important to note given the level of accuracy associated with the model (as discussed elsewhere in the report).

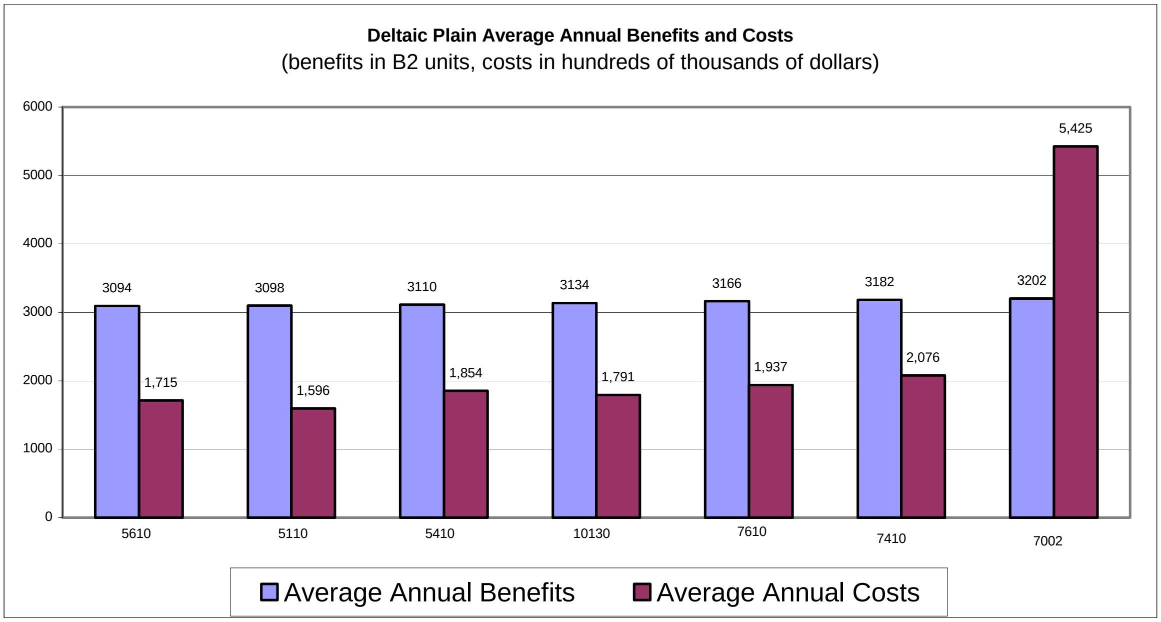


Figure E-33. Chart of Average Annual Benefits and Average Annual Costs for the Cost Effective Frameworks in the Deltaic Plain.

6.5.11 Development of the Final Array for the Chenier Plain

Habitats in the Chenier Plain were created by processes that did not include periodic overflows of the river to build and maintain land. Accordingly, frameworks for Subprovince 4 that create and preserve habitat are not constrained by the amount of water and sediment available in the Mississippi River. Consequently, the PDT evaluated Subprovince 4 separately from the other three subprovinces, which comprised the Deltaic Plain.

Because there is no nitrogen removal issue in the Chenier Plain and the habitat created in this area is expected to be fairly uniform in quality, evaluation of Subprovince 4 frameworks was solely based on land creation. Any of the outcomes here could be combined with any of the seven frameworks in the final array for the Deltaic Plain.

The cost-effective analysis produced a cost-effective curve consisting of only one cost-effective framework, M3. The PDT reviewed the cost-effectiveness analysis results and recognized that framework M3 failed to significantly address the core restoration strategy for the Chenier Plain of controlling estuarine salinities. In addition, the PDT suggested that the "Increase" planning scale be adopted as the minimum restoration level in this subprovince due to the relatively low rate of loss.

6.5.12 Development of framework of Final Array for the Chenier Plain

The executive team, as well as the vertical team and members of the framework development team, again reviewed the cost-effectiveness analysis and the PDT effort in identifying the cost-effective frameworks for the Chenier Plain. The executive team directed the PDT to develop a supplemental framework to better address the core strategy. While not cost-effective, the relative ability of framework E2 to better address the core restoration strategy (i.e., salinity control) was suggested as a starting point to develop the supplemental framework. During a 2-day meeting of the executive team and PDT, the PDT assembled the supplemental framework, which was based on the framework E2. The criteria concerning the identification and inclusion of any environmentally significant features applied in the Deltaic Plain also applied to this subprovince.

Once the features of the supplemental alternative framework were identified, costs and benefits were developed for the framework in a manner consistent with the previously analyzed alternative frameworks. This data was incorporated into the IWR-Plan database. A second iteration of the CE/ICA was run to determine the position of the supplemental alternative framework relative to the efficient frontier. Once again, the supplemental framework was intended to add to the completeness of the final array.

Eight subprovince frameworks, including the supplemental framework and the No Action Alternative, were evaluated for the Chenier Plain (**figure E-34**). As stated previously, the Chenier Plain was analyzed separately and thus frameworks that are not combinable were analyzed independently.

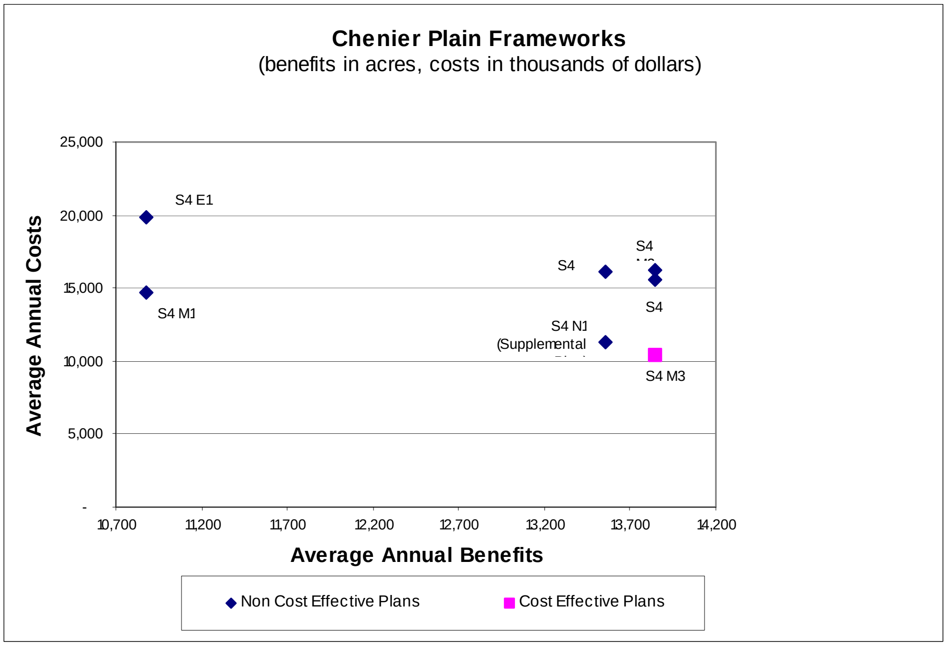


Figure E-34. Costs and Benefits (acres) for all Chenier Plain Frameworks.

A second iteration once again resulted in the identification of only one cost-effective framework, M3. However, the added supplemental framework (N1) was similar in average annual cost but produced slightly fewer average annual benefits. The features in framework M3 failed to significantly address the core restoration strategy for Subprovince 4, as previously identified by the PDT. Framework N1 included the major features of framework M3 in addition to features to address salinity control. As a result, framework M3 was dropped from the final array. The final array focuses on framework N1, the supplemental framework that was developed by modifying framework E2.

6.5.13 Details of the Final Array of Coast wide System Frameworks

As stated previously, the Chenier Plain framework can be added to any of the seven Deltaic Plain frameworks to construct coast wide frameworks, resulting in seven coast wide frameworks. **Table E-27** identifies the subprovince framework components of each of the system frameworks identified in the final array. The subprovince frameworks considered, and the features included in them, can be found in **tables E-3** through **E-6.** The final array of coast wide system frameworks identified a relatively tight grouping of possible alternatives. In comparing these alternatives, the PDT observed numerous cases of common features between the frameworks. The differences in restoration features between the frameworks, however, typically resulted in an observable difference in the make up of their beneficial outputs (i.e., the balance of marsh type and resultant species usage). The end result was that any of the frameworks in the final array could be a justifiable plan depending on the nuances applied in developing a single output value for their comparison.

In addition, the PDT recognized that the relative uncertainty of quantifying ecologic performance and sustainability versus the somewhat more certain quantification of implementation cost caused a variable effect on certainty across the range of features considered in the system wide frameworks. Particularly, larger-scale, longer range restoration features compared poorly in a comparative analysis. As a result, for the longer-range features included in the various frameworks, there were lower confidence limits that have implications for the overall timing of their implementation. Conversely, features that could be implemented and produce environmental outputs in the near-term resulted in a higher degree of confidence.

Table E-27. Overview of Final Array of Coast wide Restoration Frameworks.

	Framework Identification						
	5110	5610	5410	7610	7410	7002	10130
Subprovince 1							
M2	**X**	**X**	**X**				
E1				**X**	**X**	**X**	
N1 (Modified M2)							**X**
Subprovince 2							
R1	**X**						
M1			**X**		**X**		
M3		**X**		**X**			
E3						**X**	
N1 (Modified R1)							**X**
Subprovince 3							
R1	**X**	**X**	**X**	**X**	**X**		
M1						**X**	
N1 (Modified R1)							**X**
Subprovince 4							
N1 (Modified E2)	**X**	**X**	**X**	**X**	**X**	**X**	**X**

Of the 111 features, 79 features are contained in the final array of coast wide frameworks identified in **table E-27**. Descriptions of the 79 features are found in section 3.3.6.1.

A listing of these framework components detailing the features included in each one is presented in **table E-28**. Additional details on all of the subprovince frameworks considered, and the features included within those frameworks, as well as those included in the final array, can be found Attachment 1.

Table E-28.
Final Array of Frameworks Details.

Framework 5110

Subprovince 1, M2 (Continuous Reintroduction)

- 5,000 cfs diversion at Convent/Blind River
- 1,000 cfs diversion at Hope Canal
- 10,000 cfs diversion at White's Ditch
- 110,000 cfs diversion at American/California Bay with sediment enrichment
- 12,000 cfs diversion at Bayou Lamoque
- ◊ Mississippi River-Gulf Outlet Environmental Features and Salinity Control Study

Subprovince 2, R1 (Minimize Salinity Changes)

- 5,000 cfs diversion @ Edgard w/sediment enrichment
- Sediment delivery via pipeline at Myrtle Grove
- 5,000 cfs diversion at Myrtle Grove
- Marsh creation @ Wetland Creation and Restoration feasibility study sites
- Barrier Island restoration @ Barataria Shoreline (3000')
- 60,000 cfs diversion @ Fort Jackson

Subprovince 3, R1 (Maximize Atchafalaya Flow)

- Bayou Lafourche 1,000 cfs pump
- Convey Atchafalaya River water to Terrebonne marshes
- Freshwater introduction via Blue Hammock Bayou
- Freshwater introduction south of Lake Decade
- Penchant Basin Framework
- Relocate the Atchafalaya navigation channel
- Increase sediment transport down Wax Lake Outlet
- Rebuild historic reefs – Rebuild historic barrier between Point Au Fer and Eugene Island
- Rebuild historic reefs – Construct segmented reef/breakwater/jetty along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh Island to the west
- ◊ Study the modification of the Old River Control Structure (ORCS) operational scheme to benefit coastal wetlands
- Multi-purpose operation of the Houma Navigation Canal Lock
- Maintain land bridge between Bayous Dularge and Grand Caillou

Subprovince 4, E2 (Perimeter Structure Salinity Control):

- Gulf Shoreline Stabilization
- Calcasieu Ship Channel beneficial use
- Dedicated dredging for marsh restoration

Calcasieu Subbasin Perimeter Plan

- Salinity control at Oyster Bayou
- Salinity control at Long Point Bayou
- Salinity control at Black Lake Bayou
- Salinity control at Alkali Ditch
- New Lock at Gulf Intracoastal Waterway
- Modify existing Cameron-Creole Watershed control structures

Sabine Subbasin Perimeter Plan

- East Sabine Lake Hydrologic Restoration
- Salinity control at Black Bayou
- Salinity control at Highway 82 causeway

Mermentau Basin Freshwater Introduction

- Freshwater introduction at Pecan Island
- Freshwater introduction at Rollover Bayou
- Freshwater introduction at Highway 82
- Freshwater introduction at Little Pecan Bayou
- Freshwater introduction at South Grand Chenier

Framework 5110 (continued)

Major Features Requiring Further Study
◊ Subprovince 1 - Mississippi River-Gulf Outlet Environmental Features and Salinity Control Study
◊ Subprovince 3 - Study the modification of the Old River Control Structure (ORCS) operational scheme to benefit coastal wetlands
◊ *Denotes features that due to their size or anticipated long term impacts must be further analyzed before confirming recommendation and assigning costs and benefits comparable to other features in the framework option*

Framework 5610

Subprovince 1, M2 (Continuous Reintroduction)

- 5,000 cfs diversion at Convent/Blind River
- 1,000 cfs diversion at Hope Canal
- 10,000 cfs diversion at White's Ditch
- 110,000 cfs diversion at American/California Bay with sediment enrichment
- 12,000 cfs diversion at Bayou Lamoque
- ◊ Mississippi River-Gulf Outlet Environmental Features and Salinity Control Study

Subprovince 2, M3 (Mimic Historic Hydrology)

- 1,000 cfs diversion @ Lac des Allemands
- 1,000 cfs diversion @ Donaldsonville
- 1,000 cfs diversion @ Pikes Peak
- 1,000 cfs diversion @ Edgard
- 75,000 cfs diversion @ Myrtle Grove w/sediment enrichment
- 60,000 cfs diversion @ Fort Jackson with sediment enrichment
- Barrier Island Restoration @Barataria Shoreline (3,000')

Subprovince 3, R1 (Maximize Atchafalaya Flow)

- Bayou Lafourche 1,000 cfs pump
- Convey Atchafalaya River water to Terrebonne marshes
- Freshwater introduction via Blue Hammock Bayou
- Freshwater introduction south of Lake Decade
- Penchant Basin Framework
- Relocate the Atchafalaya navigation channel
- Increase sediment transport down Wax Lake Outlet
- Rebuild historic reefs – Rebuild historic barrier between Point Au Fer and Eugene Island
- Rebuild historic reefs – Construct segmented reef/breakwater/jetty along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh Island to the west
- ◊ Study the modification of the Old River Control Structure (ORCS) operational scheme to benefit coastal wetlands
- Multi-purpose operation of the Houma Navigation Canal Lock
- Maintain land bridge between Bayous Dularge and Grand Caillou

Subprovince 4, E2 (Perimeter Structure Salinity Control)

- Gulf Shoreline Stabilization
- Calcasieu Ship Channel beneficial use
- Dedicated dredging for marsh restoration

Calcasieu Subbasin Perimeter Framework

- Salinity control at Oyster Bayou
- Salinity control at Long Point Bayou
- Salinity control at Black Lake Bayou
- Salinity control at Alkali Ditch
- New Lock at Gulf Intracoastal Waterway
- Modify existing Cameron-Creole Watershed control structures

Sabine Subbasin Perimeter Framework

- East Sabine Lake Hydrologic Restoration
- Salinity control at Black Bayou
- Salinity control at Highway 82 causeway

Mermentau Basin Freshwater Introduction

- Freshwater introduction at Pecan Island
- Freshwater introduction at Rollover Bayou
- Freshwater introduction at Highway 82
- Freshwater introduction at Little Pecan Bayou
- Freshwater introduction at South Grand Chenier

Framework 5610 (continued)

Major Features Requiring Further Study
◊ Subprovince 1 - Mississippi River-Gulf Outlet Environmental Features and Salinity Control Study
◊ Subprovince 3 - Study the modification of the Old River Control Structure (ORCS) operational scheme to benefit coastal wetlands
◊ *Denotes features that due to their size or anticipated long term impacts must be further analyzed before confirming recommendation and assigning costs and benefits comparable to other features in the framework option*

Framework 5410

Subprovince 1, M2 (Continuous Reintroduction)

- 5,000 cfs diversion at Convent/Blind River
- 1,000 cfs diversion at Hope Canal
- 10,000 cfs diversion at White's Ditch
- 110,000 cfs diversion at American/California Bay with sediment enrichment
- 12,000 cfs diversion at Bayou Lamoque
- ◊ Mississippi River-Gulf Outlet Environmental Features and Salinity Control Study

Subprovince 2, M1 (Minimize Salinity Changes)

- 5,000 cfs diversion @ Lac des Allemands with sediment enrichment
- Sediment delivery via pipeline @ Myrtle Grove
- 5,000 cfs diversion @ Myrtle Grove
- Barrier Island Restoration @Barataria Shoreline (3,000')
- 60,000 cfs diversion @ Fort Jackson
- Sediment delivery via pipeline @ Empire
- Sediment delivery via pipeline @ Bastion Bay
- Sediment delivery via pipeline @ Main Pass (Head of Passes)
- Marsh creation @ Wetland Creation and Restoration feasibility study sites

Subprovince 3, R1 (Maximize Atchafalaya Flow)

- Bayou Lafourche 1,000 cfs pump
- Convey Atchafalaya River water to Terrebonne marshes
- Freshwater introduction via Blue Hammock Bayou
- Freshwater introduction south of Lake De Cade
- Penchant Basin Framework
- Relocate the Atchafalaya navigation channel
- Increase sediment transport down Wax Lake Outlet
- Rebuild historic reefs – Rebuild historic barrier between Point Au Fer and Eugene Island
- Rebuild historic reefs – Construct segmented reef/breakwater/jetty along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh Island to the west
- ◊ Study the modification of the Old River Control Structure (ORCS) operational scheme to benefit coastal wetlands
- Multi-purpose operation of the Houma Navigation Canal Lock
- Maintain land bridge between Bayous Dularge and Grand Caillou

Subprovince 4, E2 (Perimeter Structure Salinity Control)

- Gulf Shoreline Stabilization
- Calcasieu Ship Channel beneficial use
- Dedicated dredging for marsh restoration

Calcasieu Subbasin Perimeter Plan

- Salinity control at Oyster Bayou
- Salinity control at Long Point Bayou
- Salinity control at Black Lake Bayou
- Salinity control at Alkali Ditch
- New Lock at Gulf Intracoastal Waterway
- Modify existing Cameron-Creole Watershed control structures

Sabine Subbasin Perimeter Plan

- East Sabine Lake Hydrologic Restoration
- Salinity control at Black Bayou
- Salinity control at Highway 82 causeway

Mermentau Basin Freshwater Introduction

- Freshwater introduction at Pecan Island
- Freshwater introduction at Rollover Bayou
- Freshwater introduction at Highway 82
- Freshwater introduction at Little Pecan Bayou
- Freshwater introduction at South Grand Chenier

Framework 5410 (continued)

Major Features Requiring Further Study
◊ Subprovince 1 - Mississippi River-Gulf Outlet Environmental Features and Salinity Control Study
◊ Subprovince 3 - Study the modification of the Old River Control Structure (ORCS) operational scheme to benefit coastal wetlands
◊ *Denotes features that due to their size or anticipated long term impacts must be further analyzed before confirming recommendation and assigning costs and benefits comparable to other features in the framework option*

Framework 7610

Subprovince 1, E1 (Minimize Salinity Changes)
• 5,000 cfs diversion at Convent / Blind River
• 10,000 cfs diversion at Bonnet Carre Spillway
• Sediment delivery via pipeline at Labranche Wetlands
• Sediment delivery via pipeline at Golden Triangle Area
• Sediment delivery via pipeline at Central Wetlands
• 6,000 cfs diversion at White's Ditch
• Sediment delivery via pipeline at American / California Bay
• Sediment delivery via pipeline at Quarantine Bay
• Sediment delivery via pipeline at Fort St. Philip
• 15,000 cfs diversion at American / California Bay
• 15,000 cfs diversion at Fort St. Philip
◊ Mississippi River-Gulf Outlet Environmental Features and Salinity Control Study
Subprovince 2, M3 (Mimic Historic Hydrology)
• 1,000 cfs diversion @ Lac des Allemands
• 1,000 cfs diversion @ Donaldsonville
• 1,000 cfs diversion @ Pikes Peak
• 1,000 cfs diversion @ Edgard
• 75,000 cfs diversion @ Myrtle Grove with sediment enrichment
• 60,000 cfs diversion @ Fort Jackson with sediment enrichment
• Barrier Island Restoration @Barataria Shoreline (3,000')
Subprovince 3, R1 (Maximize Atchafalaya Flow)
• Bayou Lafourche 1,000 cfs pump
• Convey Atchafalaya River water to Terrebonne marshes
• Freshwater introduction via Blue Hammock Bayou
• Freshwater introduction south of Lake Decade
• Penchant Basin Plan
• Relocate the Atchafalaya navigation channel
• Increase sediment transport down Wax Lake Outlet
• Rebuild historic reefs – Rebuild historic barrier between Point Au Fer and Eugene Island
• Rebuild historic reefs – Construct segmented reef/breakwater/jetty along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh Island to the west
◊ Study the modification of the Old River Control Structure (ORCS) operational scheme to benefit coastal wetlands
• Multi-purpose operation of the Houma Navigation Canal Lock
• Construct a land bridge between Bayous Dularge and Grand Caillou
◊ *Denotes features that due to their size or anticipated long term impacts must be further analyzed before confirming recommendation and assigning costs and benefits comparable to other features in the framework option*

Framework 7610 (continued)

Subprovince 4, E2 (Perimeter Structure Salinity Control)
• Gulf Shoreline Stabilization • Calcasieu Ship Channel beneficial use • Dedicated dredging for marsh restoration **Calcasieu Subbasin Perimeter Plan** • Salinity control at Oyster Bayou • Salinity control at Long Point Bayou • Salinity control at Black Lake Bayou • Salinity control at Alkali Ditch • New Lock at Gulf Intracoastal Waterway • Modify existing Cameron-Creole Watershed control structures **Sabine Subbasin Perimeter Plan** • East Sabine Lake Hydrologic Restoration • Salinity control at Black Bayou • Salinity control at Highway 82 causeway **Mermentau Basin Freshwater Introduction** • Freshwater introduction at Pecan Island • Freshwater introduction at Rollover Bayou • Freshwater introduction at Highway 82 • Freshwater introduction at Little Pecan Bayou • Freshwater introduction at South Grand Chenier
Major Features Requiring Further Study
◊ Subprovince 1 - Mississippi River-Gulf Outlet Environmental Features and Salinity Control Study
◊ Subprovince 3 - Study the modification of the Old River Control Structure (ORCS) operational scheme to benefit coastal wetlands
◊ *Denotes features that due to their size or anticipated long term impacts must be further analyzed before confirming recommendation and assigning costs and benefits comparable to other features in the framework option*

Framework 7410

Subprovince 1, E1 (Minimize Salinity Changes)

- 5,000 cfs diversion at Convent / Blind River
- 10,000 cfs diversion at Bonnet Carre Spillway
- Sediment delivery via pipeline at Labranche Wetlands
- Sediment delivery via pipeline at Golden Triangle Area
- Sediment delivery via pipeline at Central Wetlands
- 6,000 cfs diversion at White’s Ditch
- Sediment delivery via pipeline at American / California Bay
- Sediment delivery via pipeline at Quarantine Bay
- Sediment delivery via pipeline at Fort St. Philip
- 15,000 cfs diversion at American / California Bay
- 15,000 cfs diversion at Fort St. Philip
- ◊ Mississippi River-Gulf Outlet Environmental Features and Salinity Control Study

Subprovince 2, M1 (Minimize Salinity Changes)

- 5,000 cfs diversion @ Lac des Allemands with sediment enrichment
- Sediment delivery via pipeline @ Myrtle Grove
- 5,000 cfs diversion @ Myrtle Grove
- Barrier Island Restoration @Barataria Shoreline (3,000')
- 60,000 cfs diversion @ Fort Jackson
- Sediment delivery via pipeline @ Empire
- Sediment delivery via pipeline @ Bastion Bay
- Sediment delivery via pipeline @ Main Pass (Head of Passes)
- Marsh creation @ Wetland Creation and Restoration feasibility study sites

Subprovince 3, R1 (Maximize Atchafalaya Flow)

- Bayou Lafourche 1,000 cfs pump
- Convey Atchafalaya River water to Terrebonne marshes
- Freshwater introduction via Blue Hammock Bayou
- Freshwater introduction south of Lake Decade
- Penchant Basin Plan
- Relocate the Atchafalaya navigation channel
- Increase sediment transport down Wax Lake Outlet
- Rebuild historic reefs – Rebuild historic barrier between Point Au Fer and Eugene Island
- Rebuild historic reefs – Construct segmented reef/breakwater/jetty along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh Island to the west
- ◊ Study the modification of the Old River Control Structure (ORCS) operational scheme to benefit coastal wetlands
- Multi-purpose operation of the Houma Navigation Canal Lock
- Maintain land bridge between Bayous Dularge and Grand Caillou

◊ *Denotes features that due to their size or anticipated long term impacts must be further analyzed before confirming recommendation and assigning costs and benefits comparable to other features in the framework option*

Framework 7410 (continued)

Subprovince 4, E2 (Perimeter Structure Salinity Control)
• Gulf Shoreline Stabilization • Calcasieu Ship Channel beneficial use • Dedicated dredging for marsh restoration **Calcasieu Subbasin Perimeter Plan** • Salinity control at Oyster Bayou • Salinity control at Long Point Bayou • Salinity control at Black Lake Bayou • Salinity control at Alkali Ditch • New Lock at Gulf Intracoastal Waterway • Modify existing Cameron-Creole Watershed control structures **Sabine Subbasin Perimeter Plan** • East Sabine Lake Hydrologic Restoration • Salinity control at Black Bayou • Salinity control at Highway 82 causeway **Mermentau Basin Freshwater Introduction** • Freshwater introduction at Pecan Island • Freshwater introduction at Rollover Bayou • Freshwater introduction at Highway 82 • Freshwater introduction at Little Pecan Bayou • Freshwater introduction at South Grand Chenier
Major Features Requiring Further Study
◊ Subprovince 1 - Mississippi River-Gulf Outlet Environmental Features and Salinity Control Study
◊ Subprovince 3 - Study the modification of the Old River Control Structure (ORCS) operational scheme to benefit coastal wetlands
◊ *Denotes features that due to their size or anticipated long term impacts must be further analyzed before confirming recommendation and assigning costs and benefits comparable to other features in the framework option*

Framework 7002

Subprovince 1, E1 (Minimize Salinity Changes)
• 5,000 cfs diversion at Convent / Blind River
• 10,000 cfs diversion at Bonnet Carre Spillway
• Sediment delivery via pipeline at Labranche Wetlands
• Sediment delivery via pipeline at Golden Triangle Area
• Sediment delivery via pipeline at Central Wetlands
• 6,000 cfs diversion at White’s Ditch
• Sediment delivery via pipeline at American / California Bay
• Sediment delivery via pipeline at Quarantine Bay
• Sediment delivery via pipeline at Fort St. Philip
• 15,000 cfs diversion at American / California Bay
• 15,000 cfs diversion at Fort St. Philip
◊ Mississippi River-Gulf Outlet Environmental Features and Salinity Control Study
Subprovince 2, E3 (Mimic Historic Hydrology)
• 5,000 cfs diversion @ Lac des Allemands with sediment enrichment
• 120,000 cfs diversion at Bayou Lafourche (Mississippi River Third Delta)
• Marsh creation @ Wetland Creation and Restoration feasibility study sites
• 90,000 cfs diversion @ Fort Jackson with sediment enrichment
• Relocation of deep draft navigation channel
• Barrier Island Restoration @Barataria Shoreline (3,000')
Subprovince 3, M1 (Maximize Geomorphic Features and River Influence)
• ◊ Third Delta (120,000 cfs diversion) with sediment enrichment
• Bayou Lafourche 1,000 cfs pump
• Relocate the Atchafalaya navigation channel
• Increase sediment transport down Wax Lake Outlet
• Rebuild Historic Reefs - Rebuild historic barrier between Point Au Fer and Eugene Island
• Rebuild Historic Reefs - Construct segmented reef/breakwater/jetty along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh Island to the west
◊ Study the modification of the Old River Control Structure (ORCS) operational scheme to increase sediment transport and to benefit coastal wetlands
• Convey Atchafalaya River water to Terrebonne marshes
• Freshwater introduction via Blue Hammock Bayou
• Freshwater introduction south of Lake Decade
• Penchant Basin Plan
• Stabilize banks of Southwest Pass
• Maintain northern shore of East Cote Blanche Bay at Point Marone
• Rebuild Point Chevreuil Reef
• Rehabilitate Terrebonne barrier islands
• Rehabilitate northern shorelines of Terrebonne/Timbalier Bays
• Backfill pipeline canals
• Multi-purpose operation of the Houma Navigation Canal Lock
• Maintain land bridge between Bayous Dularge and Grand Caillou
• Maintain land bridge between Caillou Lake and the gulf
• Stabilize gulf shoreline
• Maintain Timbalier land bridge
◊ *Denotes features that due to their size or anticipated long term impacts must be further analyzed before confirming recommendation and assigning costs and benefits comparable to other features in the framework option*

Framework 7002 (continued)

Subprovince 4, E2 (Perimeter Structure Salinity Control)
• Gulf Shoreline Stabilization • Calcasieu Ship Channel beneficial use • Dedicated dredging for marsh restoration **Calcasieu Subbasin Perimeter Plan** • Salinity control at Oyster Bayou • Salinity control at Long Point Bayou • Salinity control at Black Lake Bayou • Salinity control at Alkali Ditch • New Lock at Gulf Intracoastal Waterway • Modify existing Cameron-Creole Watershed control structures **Sabine Subbasin Perimeter Plan** • East Sabine Lake Hydrologic Restoration • Salinity control at Black Bayou • Salinity control at Highway 82 causeway **Mermentau Basin Freshwater Introduction** • Freshwater introduction at Pecan Island • Freshwater introduction at Rollover Bayou • Freshwater introduction at Highway 82 • Freshwater introduction at Little Pecan Bayou • Freshwater introduction at South Grand Chenier
Major Features Requiring Further Study
◊ Subprovince 1 - Mississippi River-Gulf Outlet Environmental Features and Salinity Control Study
◊ Subprovinces 1 and 2 - Mississippi River Delta Management Study.
◊ Subprovince 3 - Study the modification of the Old River Control Structure (ORCS) operational scheme to benefit coastal wetlands
◊ Subprovinces 3 - Third Delta (Preliminary designs, implementation costs, and benefits that were developed for this analysis would require additional detailed study to verify accuracy prior to implementation).
◊ *Denotes features that due to their size or anticipated long term impacts must be further analyzed before confirming recommendation and assigning costs and benefits comparable to other features in the framework option*

Framework 10130

Subprovince 1, Modified M2 (Supplemental Framework)

- 5,000 cfs diversion at Convent/Blind River
- 1,000 cfs diversion at Hope Canal
- 10,000 cfs diversion at White's Ditch
- 110,000 cfs diversion at American/California Bay with sediment enrichment
- 12,000 cfs diversion at Bayou Lamoque
- Increase Amite River influence by gapping dredged material banks on diversion canals
- Sediment delivery via pipeline at Labranche

∀ Rehabilitate Violet Siphon and post authorization change for diversion of water through Inner Harbor Navigation Canal for enhanced influence into Central Wetlands

- Marsh nourishment on the New Orleans East land bridge

∀ Reauthorization of the Caernarvon freshwater diversion (optimize for marsh creation)

◊ Mississippi River-Gulf Outlet Environmental Features and Salinity Control Study

∀ Authorized opportunistic use of the Bonnet Carre Spillway

Subprovince 2, Modified R1 (Supplemental Framework)

- 1,000 cfs diversion at Lac des Allemands
- 1,000 cfs diversion at Donaldsonville
- 1,000 cfs diversion at Pikes Peak
- 1,000 cfs diversion at Edgard
- Sediment delivery via pipeline at Myrtle Grove
- 5,000 cfs diversion at Myrtle Grove
- 60,000 cfs diversion at Boothville with sediment enrichment
- Barrier Island Restoration @Barataria Shoreline (3,000')

∀ Reauthorization of Davis Pond

- Marsh creation @ Wetland Creation and Restoration feasibility study sites

◊ Mississippi River Delta Management Study.

◊ Third Delta (Preliminary designs, implementation costs, and benefits that were developed for this analysis would require additional detailed study to verify accuracy prior to implementation).

Subprovince 3, Modified R1 (Supplemental Framework)

- Bayou Lafourche 1,000 cfs pump
- Relocate the Atchafalaya navigation channel
- Increase sediment transport down Wax Lake Outlet

◊ Study the modification of the Old River Control Structure (ORCS) operational scheme to benefit coastal wetlands

- Convey Atchafalaya River water to Terrebonne marshes
- Freshwater introduction via Blue Hammock Bayou
- Penchant Basin Plan
- Maintain northern shore of East Cote Blanche Bay
- Rebuild Point Chevreuil Reef
- Restore Terrebonne barrier islands

∀ Multipurpose operation of the Houma Navigation Canal (HNC) Lock

- Maintain land bridge between Caillou Lake and the Gulf Mexico
- Stabilize gulf shoreline
- Maintain land bridge between Bayous Dularge and Grand Caillou.

◊ *Denotes features that due to their size or anticipated long term impacts must be further analyzed before confirming recommendation and assigning costs and benefits comparable to other features in the framework option*

∀ *Denotes features that operate under other existing authorities and have potential benefits that could be captured under the LCA Plan. Therefore, only benefits of the feature are included in analysis.*

Framework 10130 (continued)

Subprovince 4, Modified E2 (Supplemental Framework)
• Salinity control at Oyster Bayou • Salinity control at Long Point Bayou • Salinity control at Black Lake Bayou • Salinity control at Alkali Ditch • Modify existing Cameron-Creole Watershed control structures • East Sabine hydrologic restoration • Salinity control at Black Bayou • Salinity control at Highway 82 causeway • Freshwater introduction at Pecan Island • Freshwater introduction at Rollover Bayou • Freshwater introduction at Highway 82 • Freshwater introduction at Little Pecan Bayou • Freshwater introduction at South Grand Chenier • Gulf Shoreline Stabilization • Calcasieu ship channel beneficial use • Black Bayou bypass culverts ◊ Chenier Plain Freshwater Management and Allocation Reassessment
Major Features Requiring Further Study
◊ Subprovince 1 - Mississippi River-Gulf Outlet Environmental Features and Salinity Control Study
◊ Subprovinces 1 and 2 - Mississippi River Delta Management Study.
◊ Subprovinces 3 - Third Delta (Preliminary designs, implementation costs, and benefits that were developed for this analysis would require additional detailed study to verify accuracy prior to
◊ Subprovince 3 - Study the modification of the Old River Control Structure (ORCS) operational scheme to benefit coastal wetlands
◊ Subprovince 4 - Chenier Plain Freshwater Management and Allocation Reassessment
◊ *Denotes features that due to their size or anticipated long term impacts must be further analyzed before confirming recommendation and assigning costs and benefits comparable to other features in the framework option* ∀ *Denotes features that operate under other existing authorities and have potential benefits that could be captured under the LCA Plan. Therefore, only benefits of the feature are included in analysis.*

6.6 The Final Array of Coastwide Frameworks

6.6.1 Identification of the Final Array

While B2 was used as a metric in the IWR Plan, together with average annual cost, to narrow down the large number of possible coastwide frameworks to the final array, many other factors above must be considered in determining the framework which best meets the objectives of the planning effort. The benefits values have been presented here with consideration of the uncertainties of the models used to derive them, with particular emphasis on how these uncertainties might bias the benefits values towards frameworks that include one type of restoration feature versus another.

It is also important to consider how the use of B2 values might influence the nature of the final array. Discounting environmental benefits gives greater value to benefits that are achieved earlier in the project life compared to those achieved later. For instance, an acre of marsh built at year 5 might be valued higher, due to discounting, than an acre of marsh built at year 45. The implication is that frameworks that achieve benefits earlier in the time course of assessment are valued more than a framework that achieves the same benefits later, even if the average annual benefit is the same for both frameworks. It is possible that discounting benefits adds bias in favor of frameworks that use mechanical marsh creation approaches, versus those that rely on progressive delta building and wetland nourishment to increase land area. A possible compensating factor to this effect is the use of nitrogen removal (B4) as a component of the B2 value. This has an opposite effect since this value favors diversions, particularly larger diversions. Whether the net application of these factors actually results in a balanced assessment of frameworks is, however, uncertain.

6.6.1.1 Delta Plain – Deltaic Plain

The combinations of subprovince alternatives included in the final array were selected based upon cost estimates and the potential of these alternatives to achieve the LCA ecosystem objectives. In further considering the final array and determining the best approach to achieve LCA goals, a number of addition factors must be considered. For each of the coastwide frameworks, benefits metrics have been developed indicating the effect of the actions on specific aspects of the coastal ecosystem, such as land area and habitat for species of interest. These are used in considering the final array in addition to metrics that reflect the potential of the alternatives in reducing storm surge damage.

One of the most fundamental characteristics of coastal degradation in Louisiana is the loss of land (marsh, swamp, and barrier islands) to open water. **Figure E-35** shows the amount of land estimated to result from final array alternatives.

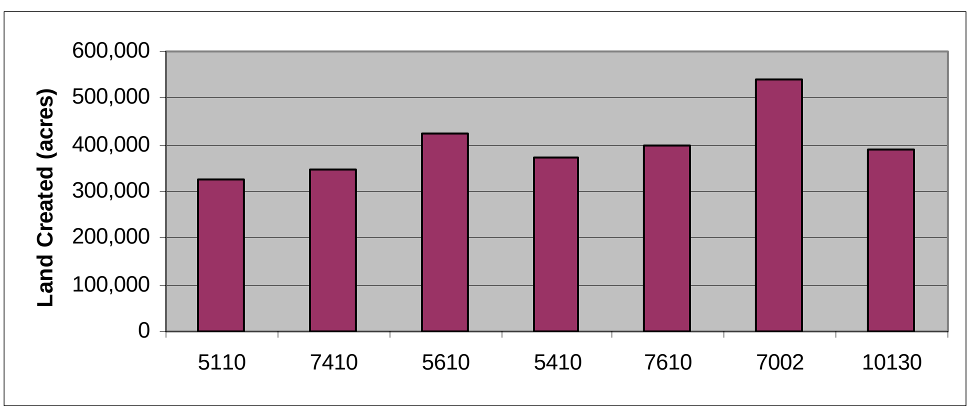


Figure E-35. Land Created by Final Array Coastwide Frameworks Compared to No Action Conditions. (No Action--Loss of over 400,000 acres by year 50)

The alternative which includes the Third Delta Conveyance Channel concept (7002) shows the highest amounts of land gain relative to No Action while several others (5610, 7610, and 10130) achieve approximately 400,000 acres of land more than would be present under No Action conditions. The features encompassed by the frameworks in the final array include very large diversions and small diversions, as well as mechanical marsh creation. Appendix C "Ecological Modeling: Louisiana Coastal Area Ecosystem Model" notes that there are limitations to the land building and nourishment desktop models that will affect all sizes of diversions. In addition, they note that estimates of land building by mechanical means, such as using dredging or sediment conveyance by pipeline, are likely to be more accurate. However, it is unclear that these limitations should prejudice any broad-scale consideration of the land building estimates in the final array. These limitations do, however, mean that relatively small differences in land building among frameworks are likely less important than overall trends, such as those described above.

An additional comparison between the frameworks in the final array related to land building, is how they performed relative to the initial planning scale estimates. These ecosystem planning scales were not design objectives but were preliminary estimates based on levels of land loss reduction. Each framework was developed around a particular scale to provide an overall range of output levels that would facilitate the identification of the most effective and efficient framework combinations.

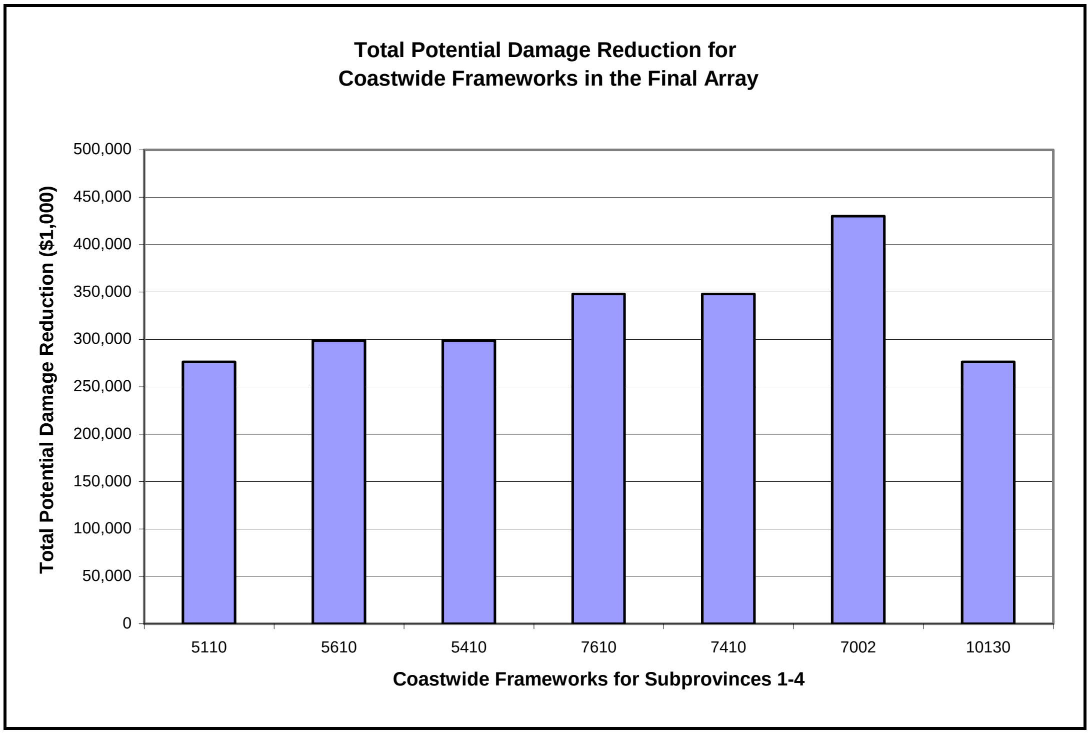
The land building output from the desktop modeling effort is presented for each framework in the final array, presented **table E-29**. This table readily displays that all of the frameworks included in the final array exceed the ecosystem scales on which they were based. Even though land building exceeded the preliminary ecosystem planning scales, the cost effective analysis was able to identify the most cost effective frameworks, regardless of the level of output.

As discussed previously, the use of acreage of land as a basis of the planning scales for this stage in the process in no way suggests that the other important objectives did not receive full consideration throughout the planning process. Acreage was used at this stage in the process not only because it was the simplest and most tangible feature around which alternatives could be formed, but also because it is an appropriate surrogate for the many important functions and values provided by Louisiana's coastal wetlands. In this sense, acreage was seen as an umbrella for the other objectives. Once alternatives were identified, the effects of alternatives relative to the other objectives were quantified during later stages of the planning process via hydrodynamic, ecological, and desktop modeling evaluations and benefit assessments.

Table E-29.
Comparison of Framework Performance Versus
Ecosystem Planning Scale Estimate.

Framework		***5110***	***7410***	***5610***	***5410***	***7610***	***7002***	***10130***
Land Created/ Preserved (ac/year)	SP 1	2,040	1,505	2,040	2,040	1,505	1,505	3,335
	SP 2	2,090	3,016	4,037	3,016	4,037	4,154	2,119
	SP 3	2,391	2,391	2,391	2,391	2,391	5,103	2,391
	SP 4	782	782	782	782	782	782	782
	TOTAL	**7,303**	**7,694**	**9,250**	**8,229**	**8,715**	**11,544**	**8,627**
Ecosystem Scale (ac/year)	SP 1	808	1,209	806	806	1,209	806	806
	SP 2	1,141	2,291	2,291	2,291	1,209	1,141	1,141
	SP 3	1,421	1,421	1,421	1,421	2,291	1,421	1,421
	SP 4	692	692	692	692	1,421	692	692
	TOTAL	**4,062**	**5,613**	**5,210**	**5,210**	**6,130**	**4,060**	**4,060**

Closely related to the amount of land versus water within the coastal system is the effect of reducing storm surge. In each subprovince the potential level of damage that would be incurred during a hypothetical hurricane was evaluated in terms of WRUs. WRUs are an accounting of numbers and values of structures, as well as the quantity and value of agricultural land, in an area. Storm surge reductions were estimated based on additional wetland acreage equivalent to the desired planning scale levels of Reduce, Maintain, and Increase for each subprovince. As the estimates are based on the scales rather than the modeling output, the limitations of land building estimates described above do not apply. Rather, a net potential damage reduction was developed for each scale level in each subprovince. The results of these analyses for the final array of frameworks are shown in **figure E-36**. As these analyses are based on the scale acreages, framework 10130 should be considered very similar to 5110.



Note: 1- All coastwide frameworks include Framework Increase 2 (E2) in Subprovince 4
2- Damage reduction values based on assessment of Water Resources Units

Figure E-36. Total Potential Damage Reduction for Coastwide Frameworks.

The differences between individual frameworks represent a change in potential storm damage reduction. An actual value for these changes in protection could be estimated by calculating a fully funded cost based on the difference in the value of potential damage reduction between frameworks. This would represent the dollar value of flood protection that the increment of damage could support. While these calculations have not been made, a rough estimate confirms that the difference between the values shown and the corresponding implementation value is on the same order of magnitude. In other words, the step to a larger framework based on this particular feature of output would not be cost-effective.

Examination of storm damage reduction data for all alternatives indicates that frameworks in the final array that achieve a level of potential damage reduction less than the maximum typically are more cost-effective in achieving these outputs. Frameworks 5110, 5410, 5610, 10130, 7410, and 7610, which form the breakpoint of the cost-effective curve, tend to be the most cost-effective in achieving potential damage reduction but do not provide the greatest level of that output.

The comprehensive benefit protocol (B2) used in the cost-effectiveness analysis assesses the success of the frameworks in achieving the ecosystem objectives of LCA as well as the land building potential. To consider the final array of frameworks, in terms of their success in achieving individual ecosystem benefits, benefits protocols B1 and B4 were developed (Hawes et al. 2003). B1 can be used to examine the frameworks in terms of ecosystem primary productivity and provision of fish and wildlife habitat. **Figure E-37** shows the performance of the final array for B1 relative to No Action.

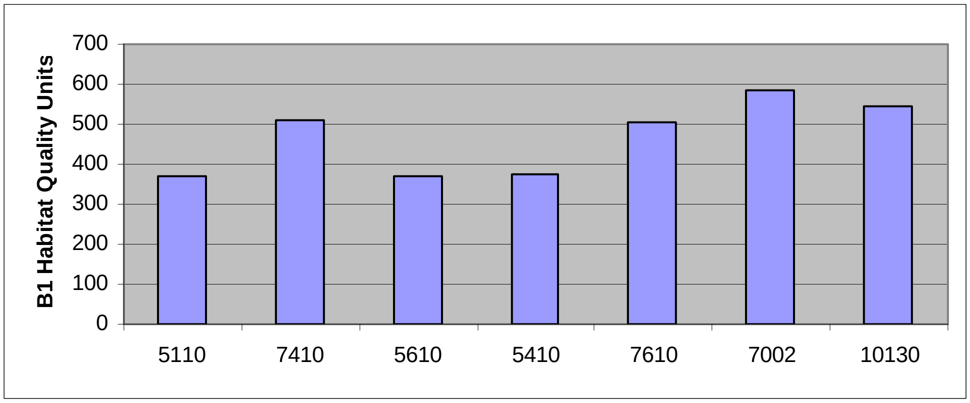


Figure E-37. Net Mean Annual Habitat Quality Units (Benefits Protocol B1) for the Final Array Coastwide Frameworks Compared to No Action Conditions (No Action at Year 50= 5,700 HQUs).

The limitations of the modeling on which the benefits calculations are based should be further considered here as the Habitat Quality Units and include estimates of habitat suitability for selected fish and wildlife species using the estuary. Appendix C "Ecological Modeling: Louisiana Coastal Area Ecosystem Model" notes that the box models used to estimate salinity changes across subprovinces mask salinity gradients within a box. Some of the species, (birds, mammals, reptiles) respond more to the vegetated community type, while others (fish, shrimp, oysters) respond to changes in salinity along the estuarine gradient. This means that some species are more sensitive to abrupt changes in the salinity gradient due to model limitations. Habitat for species that use higher salinity areas of the estuary are thus likely underestimated, while moderate salinity habitat is probably overestimated. B1 Habitat Quality Units include categories for habitats in low, moderate, and higher salinity environments. To some extent the uncertainties in habitat suitability predictions may counteract one another, but it is likely that B1 values for frameworks including very large diversions are more uncertain than for other frameworks, as these limitations to the modeled salinity gradient are more pronounced for large diversions.

The variation in B1 Habitat Quality Units should be used to show broad scale differences among frameworks, with less benefit over No Action (e.g., 5110, 5610 and 5410), compared to those with higher benefits (e.g., 7002 and 10130), rather than to provide a relative measure of performance between individual frameworks, see **figure E-37**.

The second LCA ecosystem objective concerns reducing nutrient delivery to the shelf by routing Mississippi River water through estuarine basins. The B4 benefit protocol is used to reflect success in achieving this objective and is shown in **figure E-38**.

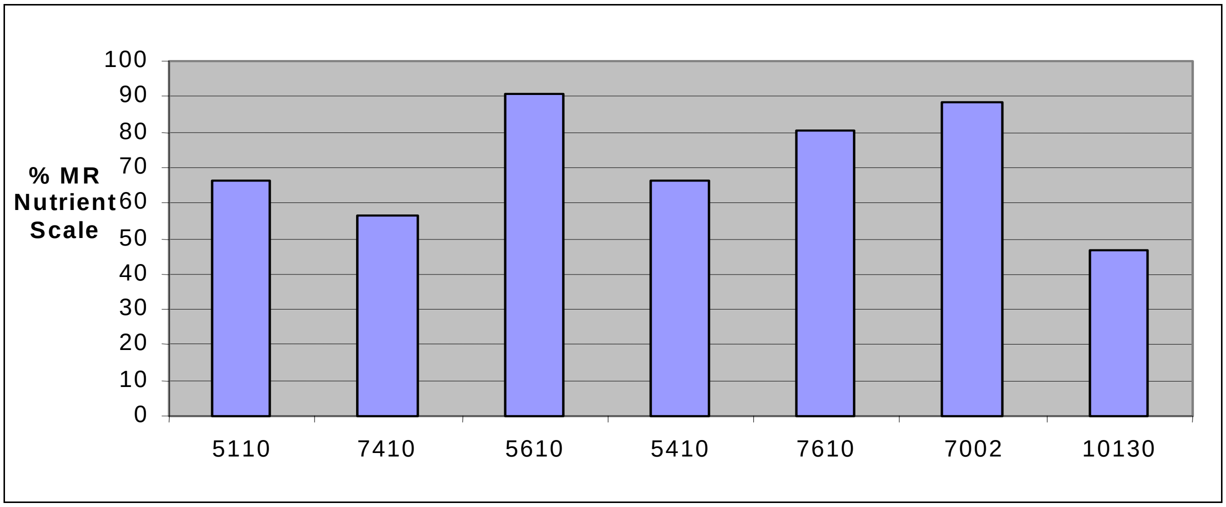


Figure E-38. Mean Annual Percent of Mississippi River Nutrient Reduction Scales Achieved (Benefits Protocol B4) for the Final Array Coastwide Frameworks (Initial Results) Compared to No Action Conditions. (No Action – Over 96 Percent, Includes Removal from Atchafalaya River Waters in Subprovince 3 Under Existing Configuration).

The reduction in nutrients reaching the shelf is shown in **figure E-38** as the percentage of the Mississippi River nutrient reduction scale achieved by the framework (100 percent would be equivalent to the total reduction scale of 30 percent, not all of the nutrients present in the river). The uncertainties in modeling identified by Appendix C "Ecological Modeling: Louisiana Coastal Area Ecosystem Model" suggest that the nutrient reduction potential of very large river diversions is likely underestimated in the analyses presented here. They also note that there may be some, but much smaller in absolute magnitude, overestimates for smaller diversions. **Figure E-38** also shows the frameworks that include the Third Delta Conveyance Channel concept or other large diversions with high nutrient removal, despite these limitations.

Given the programmatic nature of the LCA Plan, the results of this modeling effort serve primarily to differentiate among alternatives with respect to their relative impacts on Gulf hypoxia. Accurate, quantitative estimates of the effects of particular restoration features on Gulf hypoxia will be developed at the project-level, when critical information regarding the location, size, and operation of such features will be available.

As well as assessing the frameworks relative to LCA ecosystem objectives, benefits protocols have been developed to identify the effects of frameworks on habitats for particular species groupings. **Table E-30** shows an assessment of framework effects on habitat for species using lower, moderate, and higher salinity zones of the estuary, and habitats for selected species grouped according to their importance for commercial harvest and recreational use, with oyster habitat shown individually. Importantly, the magnitude of negative values for the differences between frameworks and No Action conditions should be considered relative to absolute values for No Action to more fully assess the nature of the potential impact. This shows that for the most part negative values for moderate salinity habitats and habitats for commercial and recreational species groups are very small compared to no action predictions, generally representing less than a 5 percent change. Differences are greater for oysters and the higher salinity species grouping. However, as has already been recognized, the modeling approaches used in this study mask changes in the salinity gradient, and this is particularly the case at the higher salinity range. Thus, the values in **table E-30** of potential impact to oyster habitats and habitat for higher salinity species (including oysters) are overestimates. For oysters and higher salinity species habitats, the values are best interpreted to show the differences among the coastwide frameworks in terms of their greater or lesser effects rather than to project the magnitude of benefits or impacts to habitats for species groups.

Table E-30.
Mean Annual Habitat Units for B6 Species Groupings for the Final Array Coastwide Frameworks Compared to No Action Conditions.
Values for No Action year 50 conditions included for reference.

	Species Habitat Grouping					
Mean Annual Habitat Units for Coastwide Frameworks At Year 50	**Lower Salinities**	**Moderate Salinities**	**Higher* Salinities**	**Commercial Species**	**Recreational Species**	**Oysters ***
No Action	5,473	13,254	10,215	11,246	8,820	8,480
(Framework minus No Action)						
5110	740	-187	-2,119	-639	-187	-2,450
7410	652	63	-1,586	-364	-78	-1,739
5610	910	-351	-2,502	-896	-76	-2,574
5410	774	-207	-2,116	-651	-166	-2,450
7610	788	-81	-1,972	-610	12	-1,863
7002	799	-206	-2,232	-881	82	-2,629
10130	777	11	-1,923	-462	-95	-2,452

* *See text for limitations*.

The frameworks within the final array include many different types and scales of restoration features. One way in which the types of features can be gauged is by the amount of Mississippi River water and suspended sediment diverted into the estuarine basins. Frameworks which rely on more mechanical means of marsh creation to achieve land building (**figure E-38**) will divert less suspended sediment than those that rely on natural delta-building processes. **Figure E-39** shows the variation in sediment diverted for the final array frameworks. With the exception of Subprovince 3, where Atchafalaya River waters distribute sediments, very little suspended sediment reaches the estuarine basins under No Action conditions.

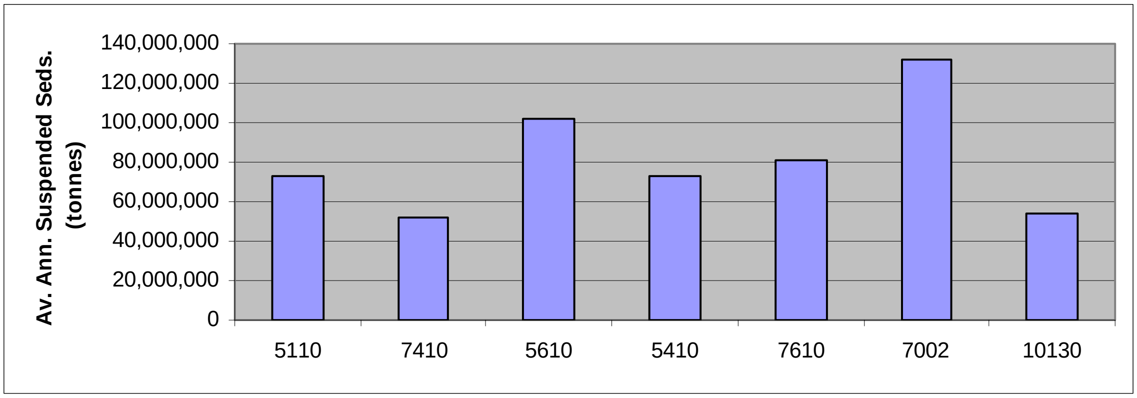


Figure E-39. Annual Amount of Suspended Sediment Diverted into Estuarine Basins for Each Coastwide Framework in the Final Array.

In comparing the coastwide frameworks in the final array, it can be readily observed that the individual frameworks each have strengths in different areas of output. Framework 7002 results in the largest magnitude of outputs in several benefit categories. However, the overall size of the framework also results in the largest costs and, as a result, a cost-effectiveness that appears far above the breakpoint of the cost-effective curve.

In terms of land building (B3) frameworks 5610, 7610, and 10130 are the next most productive. In the measure of overall habitat quality (B1) output frameworks 10130, 7410, and 7610 are the most productive. This relative effectiveness may also be observed in the detailed habitat output data presented in **table E-30** for various composite salinity and species groups. These same three frameworks appear to provide some balance of outputs across these diverse groups.

Two benefit metrics involve the introduction of riverine resource to the wetlands. For benefit metric B4, the ability of the frameworks to address the Mississippi River nutrient reduction scale frameworks 5610, 7002 and 7610 address the largest percentages. This is the only graphed metric in which framework 7002 does not produce the largest effect. The minimum percentage of the scale addressed by any framework is slightly less than 50 percent. Looking into the future, an increase in the ecosystems ability to utilize nitrogen should be a secondary effect of increased wetland building and overall habitat quality.

The second metric involving riverine resources is the introduction of suspended sediment. For this metric the frameworks that divert the largest volume of river water would obviously produce the largest effect. Beyond framework 7002, framework 5610 produces the most significant effect for this metric. It should be noted that this metric does not account for sediments dredged from the river, which is accounted for in the land building metric.

After review of this information, as well as the cost-effectiveness analysis, it appears that frameworks 7610 and 10130 produce very similar suites of beneficial output. While framework 10130 does sacrifice some nutrient utilization, it produces better composite habitat output (B1) and only slightly less land building (B3). In terms of cost-effectiveness, framework 10130 results in a lower overall cost and slightly lower unit cost then framework 7610. In addition, framework 10130 represents the modified supplemental framework to the final array. This framework is a consensus framework developed and analyzed to ensure, to the maximum extent possible, the inclusion of environmentally significant features as well as completeness and cost-effectiveness.

6.6.1.2 Chenier Plain - Subprovince 4

In Subprovince 4, the primary benefit variable used to identify the cost-effective frameworks was B3: Land Building. The relative success of the Subprovince 4 alternatives in creating or preserving land is shown in **figure E-40**. There are two main groupings of frameworks. M1 and E1 produce less than 33,000 acres of land relative to No Action while all other frameworks create around 40,000 acres.

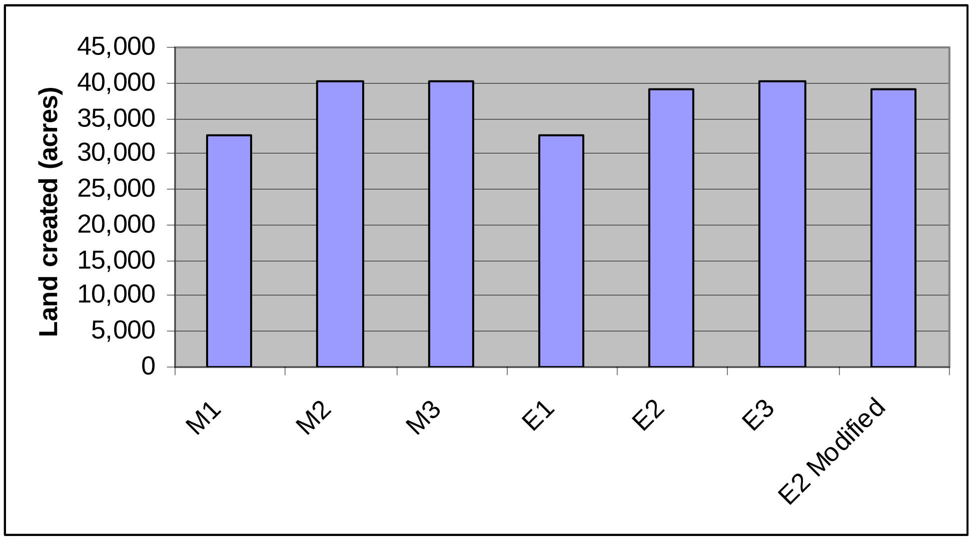


Figure E-40. Land Created by Subprovince 4 Frameworks Compared to No Action Conditions. (No Action - Loss of Over 47,000 Acres by Year 50).

Benefits protocol B1 can be used to examine the frameworks in terms of their net ecosystem primary productivity and provision of fish and wildlife habitat. The No Action value for Habitat Quality Units (B1) at year 50 for Subprovince 4 is 2,250. While all the mean annual values for the alternatives are less than this, implying negative benefit or impact, the change from No Action is less than 5 percent. These values for the Chenier Plain are also subject to the same methodological limitations as described for the Deltaic Plain above. Given these limitations and the small changes from the No Action conditions described by B1 for the alternatives, B1 cannot be used to distinguish among alternative frameworks in the Chenier Plain.

Table E-31 shows an assessment of Subprovince 4 alternative framework effects on habitat for species using lower, moderate and higher salinity zones of the estuary, and habitats for selected species grouped according to their importance for commercial harvest and recreational use, with oyster habitat shown individually. Importantly, the magnitude of negative values for the differences between frameworks and No Action conditions should be considered relative to absolute values for No Action to more fully assess the nature of the potential impact. With the exception of oysters, the effects of the alternatives on habitat for the species groupings are relatively minor. As discussed above, modeling approaches used in this study likely result in underestimates of species habitats in higher salinity areas of the estuary. Although the magnitude of the differences among alternatives is small relative to No Action, it does appear that alternatives E2 and "E2 Modified" provide slightly improved habitats for fresher species groupings and concomitantly present slightly more risk to habitats for moderate and higher salinity species groupings.

Table E-31.
Mean Annual Habitat Units for B6 Species Groupings for the Subprovince 4 Alternative Frameworks Compared to No Action Conditions.
Values for No Action year 50 conditions included for reference.

	Species Habitat Groupings					
Mean Annual Habitat Units for Chenier Plain Frameworks At Year 50	**Low**	**Moderate**	**Higher**	**Commercial**	**Recreational**	**Oysters**
No Action	1,535	2,621	1,482	2,000	1,854	408
(Framework Minus No Action)						
M1	-121	-47	27	-72	-58	-111
M2	-130	-71	35	-79	-73	-35
M3	-130	-70	36	-78	-73	-34
E1	-121	-47	27	-72	-58	-111
E2	-25	-135	-114	-105	-77	-45
E3	-130	-70	36	-78	-73	-34
E2 Modified	-25	-135	-114	-105	-77	-45

The objective of salinity management capability in this subprovince is indicative of the limited freshwater resources available and the need to preserve and maintain fresh marsh habitat. As can be seen in **table E-31**, frameworks E2 and “E2 Modified” present a better opportunity to achieve lower salinity related outputs.

Following are the implementation costs and O&M costs for each framework in the final array broken down by subprovince.

6.6.2 Ecosystem Sustainability

The USACE Environmental Operating Principles promote projects that "Strive to achieve environmental sustainability." The need to move towards ecosystem sustainability was considered throughout the LCA planning process, from development of the Study Guiding Principles and identification of core ecosystem restoration strategies to the formulation of specific features and coastwide alternatives.

The Study Guiding Principles call for achieving "ecosystem sustainability" and have a strong preference for alternatives that "mimic natural processes and rely on natural cycles and processes for their operation and maintenance." In identifying core strategies for restoration, members of the Framework Development Team emphasized these same concepts. Most notably, the core strategies identified for the Deltaic Plain center around river re-introduction as the primary way to restore some semblance of the natural processes that create and sustain deltaic wetlands. Consistent with this core strategy, approximately three fourths of the potential restoration features identified for Subprovinces 1 and 2 involve river re-introduction. Most of the remaining features in those subprovinces are designed to provide near-term solutions and/or restore critical structural features of the ecosystem.

The emphasis on river re-introduction and sustainability was carried forward into the development of the subprovince alternatives. River-reintroduction is the foundation of two of the three conceptual frameworks used to develop alternatives for Subprovinces 1 and 2. For example, the "mimic natural hydrology" framework seeks to replicate the natural over-bank flow, crevassing, and distributary flow characteristic of the deltaic system. Moreover, smaller diversions are included in the alternatives that have a greater emphasis on marsh creation in an effort to extend the duration and effectiveness of such features. As a result of this continuous emphasis on sustainability, the final array alternatives, while representing a mix of approaches to coastal restoration, nevertheless rely extensively on river-reintroduction projects for restoring coastal Louisiana.

The final array alternatives have the potential to provide environmental benefits throughout the 50-year planning period. The potential environmental benefits of the frameworks in the final array have been estimated based on the output of the models used for the LCA Ecosystem Restoration Study. **Figure E-41** shows the “B2” benefits over ten year intervals for each framework in the final array and the No Action alternative. (The “B2” benefits represent habitat quantity and quality, and the nutrient removal capacity of each framework.) **Figure E-41** shows that each framework would have a substantial and sustained increase in “B2” benefits. It is important to note that the actual rate at which the frameworks would provide the estimated environmental benefits would depend upon the timing and sequence of implementation of the specific features contained within the respective framework. However, it is expected, based on the reasons discussed above, that the realized effect of the LCA frameworks relative to sustainability would be consistent with the trends identified in **figure E-41**.

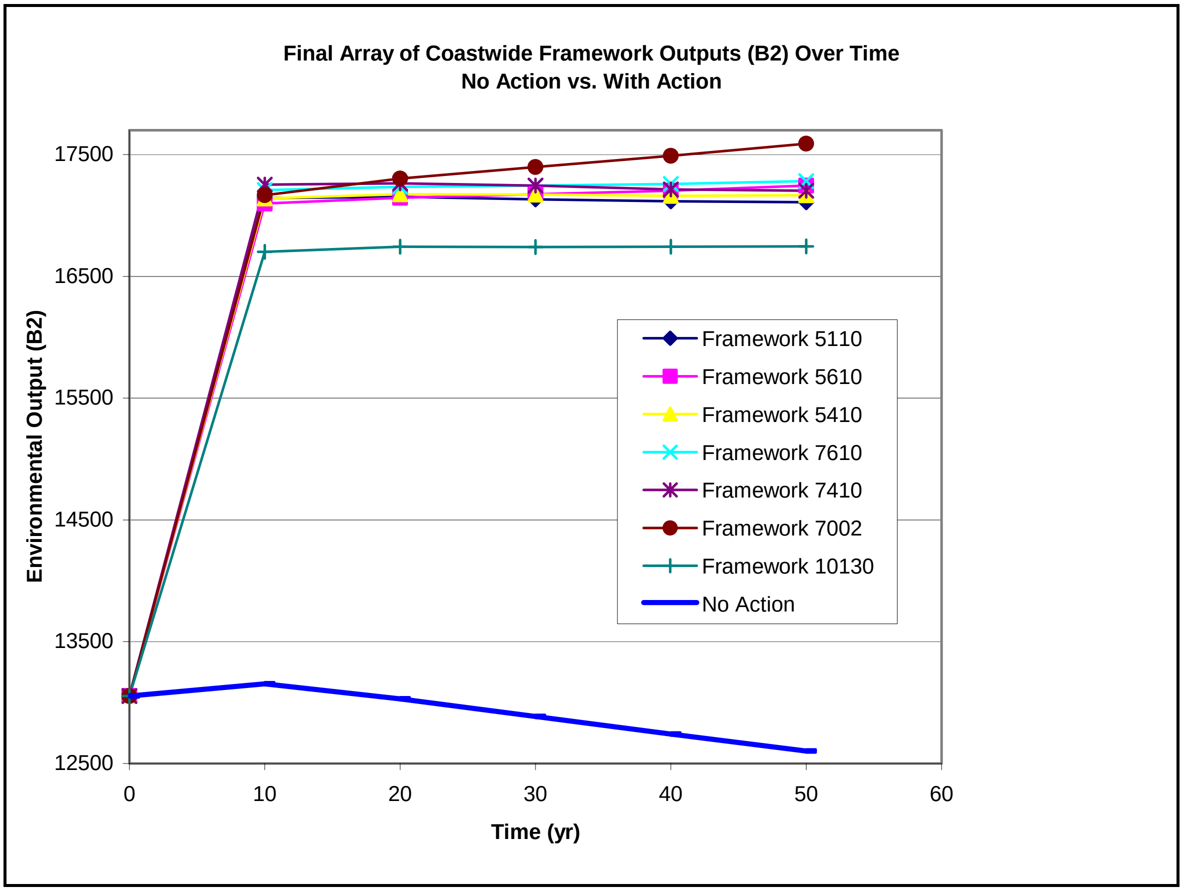


Figure E-41. Final Array of Coastwide Frameworks Outputs (B2) Over Time for Subprovinces 1-3.

The final array alternatives also have the potential to provide environmental benefits beyond the 50-year framework horizon. For example, river re-introduction features have the potential to continue to provide benefits as long as such structures are maintained and operated in a manner consistent with existing ecosystem needs. Additionally, in the case of river re-introduction features, the bulk of the cost is concentrated in the design and construction stages. Accordingly, the long-term benefits (i.e., those beyond 50 years) come at minimal cost. Moreover, the complex issues identified for further study as part of the LCA Report (e.g., the Third Delta, relocation of navigation channel) are actions that would have long-term effects well beyond the 50-year framework horizon, either by mimicking natural deltaic process (as is the case with the Third Delta) or by enabling the return of more natural deltaic dynamics along the Mississippi River (as in the case of the proposal to relocate the navigation channel).

Inspection of the with-project action versus No Action trends for the individual alternative frameworks, which make up the final array in each of Subprovinces 1and 2, reveals a similar pattern of sustainability (**figures E-42 and E-43**). In Subprovince 3 although some with-action alternatives show a decreasing trend over the 50-year period of analysis, the slope of decline is reduced (**figure E-44**). This is consistent with the possible conceptual scenarios for coastal restoration since degradation is a natural function necessary in the system. The modification of the rate of decline indicates an extension in the sustainable life of the system. This would be particularly applicable in an older deltaic system. It can be seen in the composite chart of B2 outputs for Deltaic Plain shown above that overall trends in the coastwide frameworks in the final array are typically stable.

In Subprovince 4 the B2 output value did not apply due to the nature of the Chenier Plain system. In place of B2, land building was used. As can be seen in **figure E-45** the trends in this subprovince are similar to those seen in Subprovince 3. Again this is consistent with a trend of sustainability in an managed system and the described conceptual restoration scenarios.

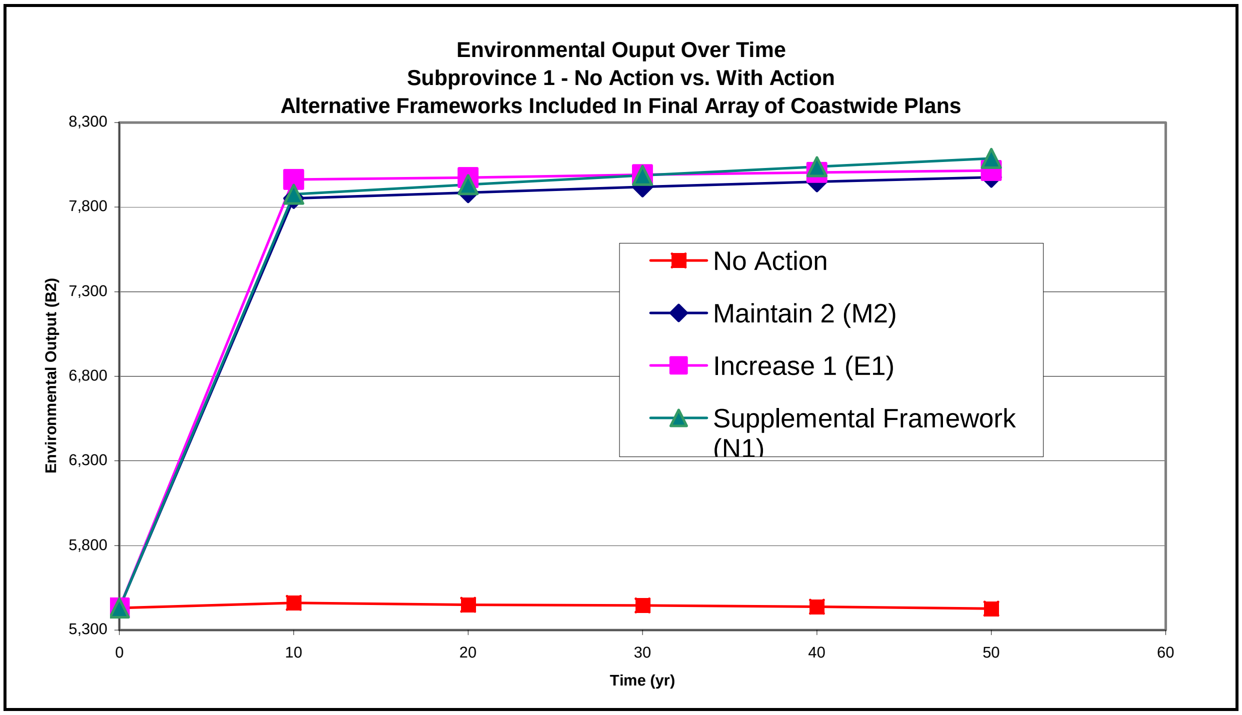


Figure E-42. Environmental Output (B2) Over Time. Subprovince 1 – No Action vs. With Action.

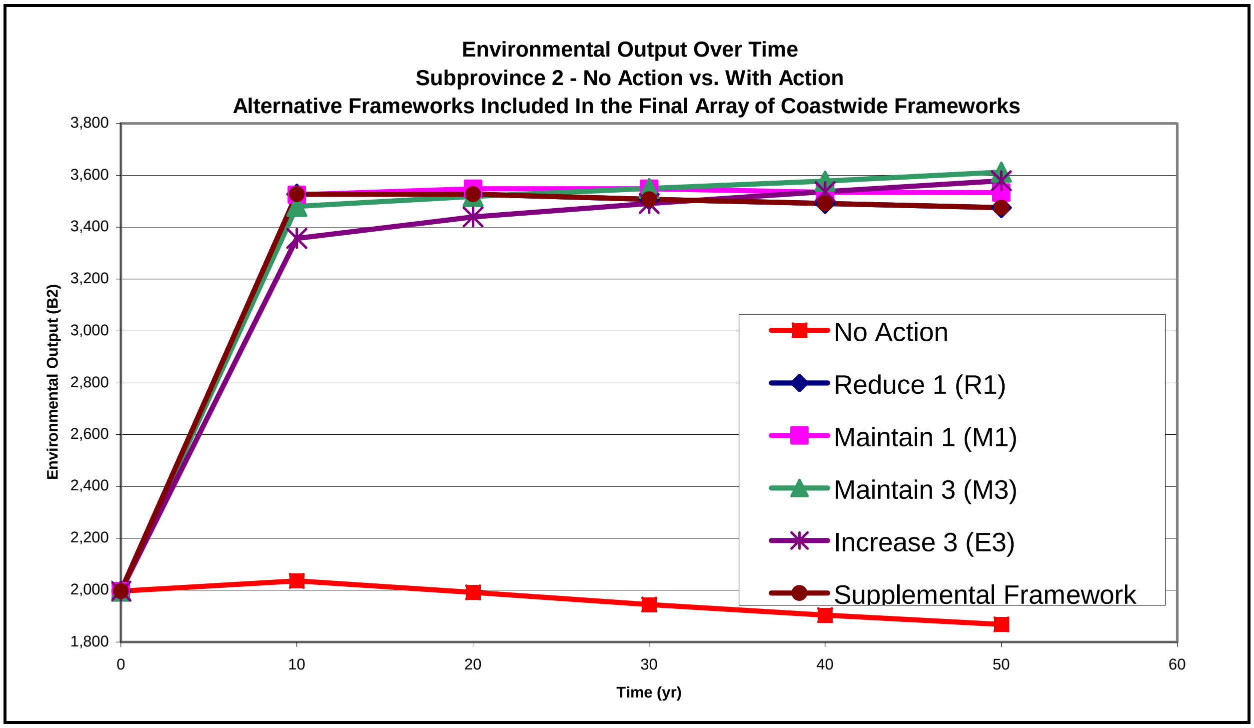


Figure E-43. Environmental Output (B2) Over Time. Subprovince 2 – No Action vs. With Action.

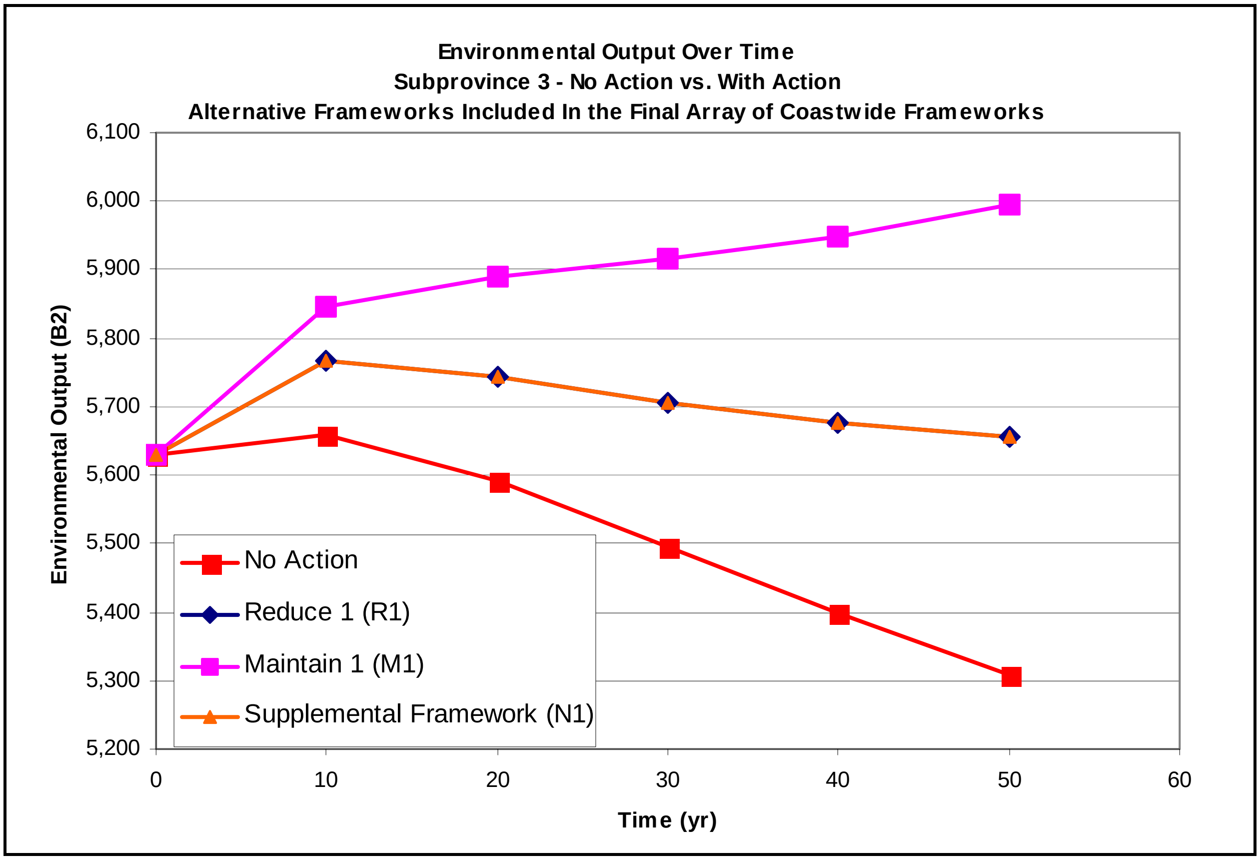


Figure E-44. Environmental Output (B2) Over Time. Subprovince 3 – No Action vs. With Action.

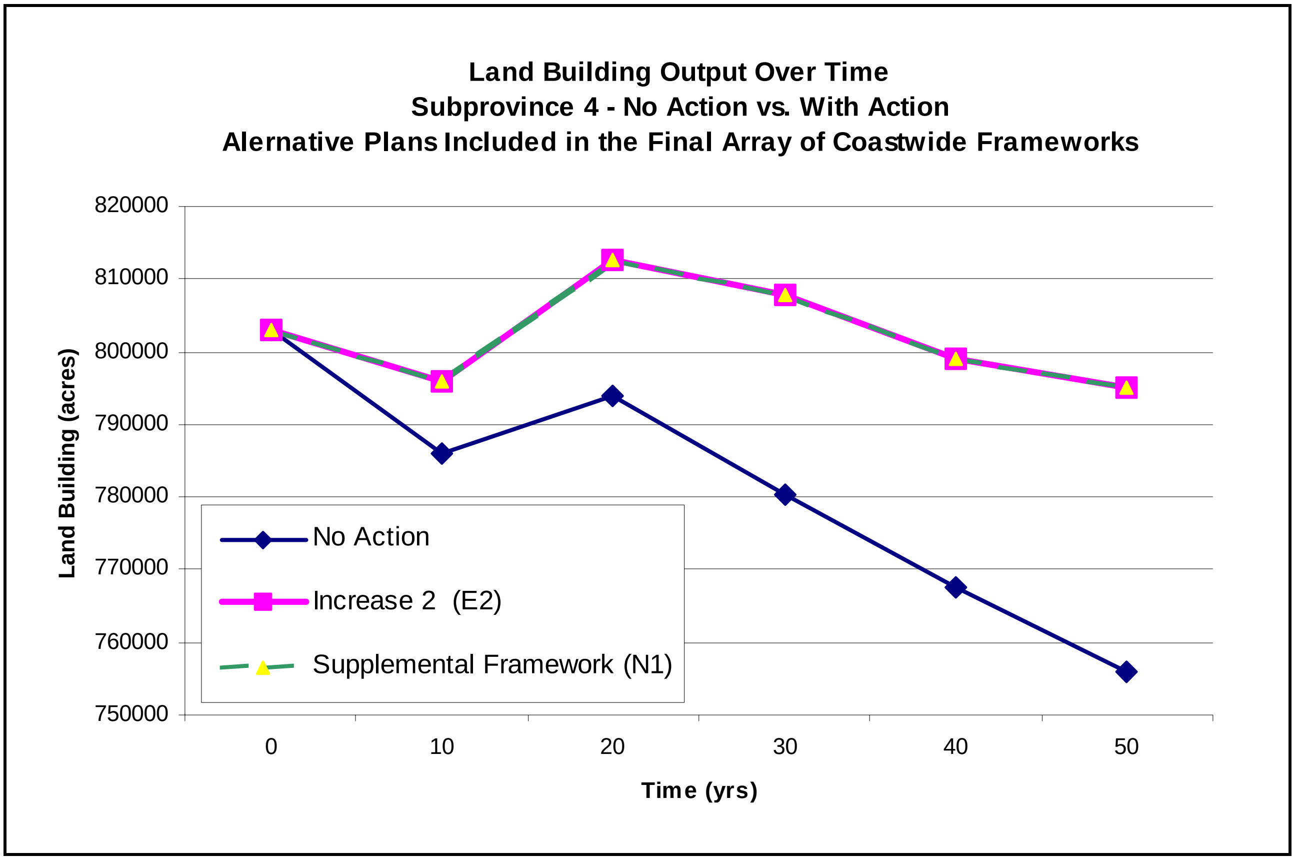


Figure E-45. Environmental Output (Land Building – B3) Over Time. Subprovince 4 – No Action vs. With Action.

The following tables (**tables E-32 to E-45)** present the cost estimates for the subprovince alternative frameworks included in each of the coastwide alternative frameworks in the final array. In addition, a summary cost table showing total cost across the four subprovinces, is provided for each of the coastwide alternative frameworks in the final array.

Table E-32.
Framework 5110 Subprovince 1 -- M2
Cost Estimates
(June 2003 Price Levels).

Item			Cost ($)
IMPLEMENTATION COSTS			
5,000 cfs diversion @ Convent / Blind River.		$	26,964,000
1,000 cfs diversion @ Hope Canal		$	15,300,000
10,000 cfs diversion @ White's Ditch		$	35,200,000
110,000 cfs diversion NA/California Bay		$	14,900,000
Sediment Enrichment at NA/California Bay		$	135,000,000
12,000 cfs diversion @ Bayou Lamoque		$	320,000
	SUBTOTAL	$	227,684,000
Miss. River Gulf Outlet Environmental Features & Salinity Control Study			Recommended Study
Relocations		$	6,028,000
	SUBTOTAL	$	233,712,000
Engineering & Design (E&D) / Supervision & Administration (S&A)		$	63,102,240
Real Estate		$	187,794,000
	SUBTOTAL	$	484,608,240
Monitoring		$	4,846,082
Adaptive Management		$	14,538,247
	TOTAL IMPLEMENTATION COST	**$**	**503,992,570**
O&M - Structures	$ 416,236		
O&M - Implementation	$ 15,742,500		
TOTAL O & M COST	**$ 16,158,736**		

Table E-32.
Framework 5110 Subprovince 2 --R1
Cost Estimates
(June 2003 Price Levels).

Item			Cost ($)
IMPLEMENTATION COSTS			
5,000 cfs diversion at Edgard		$	28,200,000
Sediment Enrichment at Edgard		$	75,000,000
5,000 cfs diversion at Myrtle Grove		$	34,300,000
Sediment delivery via pipeline at Myrtle Grove		$	112,000,000
Marsh Creation Study Sites		$	300,113,000
Barrier Island restoration at Barataria Shoreline.		$	502,460,000
Barrier Island Renourishment		$	1,127,600,000
60,000 cfs diversion @ Ft. Jackson		$	16,800,000
	SUBTOTAL	$	2,196,473,000
Relocations		$	400,000
	SUBTOTAL	$	2,196,873,000
Engineering & Design (E&D) / Supervision & Administration (S&A)		$	593,155,710
Real Estate		$	224,126,000
	SUBTOTAL	$	3,014,154,710
Monitoring		$	30,141,547
Adaptive Management		$	90,424,641
	TOTAL IMPLEMENTATION COST	**$**	**3,134,720,898**
O&M - Structures	$ 268,623		
O&M - Implementation	$ 12,678,000		
TOTAL O & M COST	**$ 12,946,623**		

Table E-32.
Framework 5110 Subprovince 3 - R1
Cost Estimates
(June 2003 Price Levels).

Item				Cost ($)
IMPLEMENTATION COSTS				
1,000 cfs pump @ Bayou Lafourche			$	90,000,000
Northern Terrebonne marshes				
Avoca Island Levee Diversion			$	43,300,000
Repair GIWW banks			$	44,000,000
Enlarge GIWW constrictions below Gibson & in Houma			$	26,400,000
Channel Enlargement			$	18,500,000
Freshwater intro to SW Terrebonne via Blue Hammock Bayou			$	18,500,000
Freshwater intro South of Lake Decade			$	2,200,000
Penchant Basin Plan			$	9,720,000
Relocate the navigation channel			$	93,000,000
Increase sediment transport down Wax Lake Outlet			$	16,800,000
Rebuild Historic Reefs - Pt. Au Fer to Eugene Island			$	32,800,000
Rebuild Historic Reefs - Eugene Island toward Marsh Island			$	97,000,000
Maintain land bridge between Bayous Dularge & Grand Caillou			$	8,100,000
		SUBTOTAL	$	500,320,000
Modify Old River Control Structure (ORCS) Operations Scheme to Benefit Coastal Wetlands				Recommended Study
Multi-purpose operation of the Houma Navigation Canal Lock				Included in Real Estate Costs
Relocations			$	14,000,000
		SUBTOTAL	$	514,320,000
Engineering & Design (E&D) / Supervision & Administration (S&A)			$	138,866,400
Real Estate			$	80,577,000
		SUBTOTAL	$	733,763,400
Monitoring			$	7,337,634
Adaptive Management			$	22,012,902
TOTAL IMPLEMENTATION COST			**$**	**763,113,936**
O&M – Structures	$	5,164,478		
O&M – Implementation	$	-		
TOTAL O & M COST	**$**	**5,164,478**		

Table E-32.
Framework 5110 Subprovince 4 - E2
Cost Estimates
(June 2003 Price Levels).

Item		Cost ($)
IMPLEMENTATION COSTS		
Gulf Shoreline Stabilization (Mermentau Ship Channel to Rollover Bayou)	$	69,000,000
Calcasieu Ship Channel Beneficial Use	$	100,000,000
Oyster Bayou Structure (weir)	$	400,000
Long Point Structure (weir)	$	300,000
Alkali Ditch Structure (weir)	$	800,000
Black Lake Bayou Structure (weir)	$	500,000
New Lock at GIWW	$	75,000,000
Modify Cam-Creole Structures	$	600,000
FW Introduction Across Hwy 82 in Mermentau Basin (5 locations)	$	19,958,000
East Sabine Hydrologic Restoration	$	10,740,000
Black Bayou Structure (weir)	$	500,000
Hwy 82 Causeway Weir	$	8,000,000
SUBTOTAL	$	285,798,000
Relocations	$	-
SUBTOTAL	$	285,798,000
Engineering & Design (E&D) / Supervision & Administration (S&A)	$	77,165,460
Real Estate	$	21,891,000
SUBTOTAL	$	384,854,460
Monitoring	$	3,848,545
Adaptive Management	$	11,545,634
TOTAL IMPLEMENTATION COST	**$**	**400,248,638**

O&M - Structures	$	3,031,076
O&M - Implementation	$	-
TOTAL O & M COST	**$**	**3,031,076**

Table E-33.
Framework 5110
Summary of Implementation Costs.

	Sub 1	Sub 2	Sub 3	Sub 4	Total
Initial Construction Cost	$ 92,684,000	$ 1,068,873,000	$ 500,320,000	$ 285,798,000	$ 1,947,675,000
Continuing Construction Cost	$ 135,000,000	$ 1,202,600,000	$ -	$ -	$ 1,337,600,000
Real Estate	$ 187,794,000	$ 224,126,000	$ 80,577,000	$ 21,891,000	$ 514,388,000
Relocations	$ 6,028,000	$ 400,000	$ 14,000,000	$ -	$ 20,428,000
E&D / S&A	$ 63,102,240	$ 593,155,710	$ 138,866,400	$ 77,165,460	$ 872,289,810
Monitoring & Adaptive Management	$ 19,384,330	$ 120,566,188	$ 29,350,536	$ 15,394,178	$ 184,695,232
Total Construction	$ 503,992,570	$ 3,134,720,898	$ 763,113,936	$ 400,248,638	$ 4,802,076,042
Project Implementation Reports (GI)					$ 240,103,802
PED					$ 144,062,281
				Total Cost	$ 5,186,242,126
				Total Cost Rounded	$ 5,186,000,000
Annual Costs					
O&M - Structures	$ 416,236	$ 268,623	$ 5,164,478	$ 3,031,076	$ 8,880,413
O&M - Implementation	$ 15,742,500	$ 12,678,000	$ -	$ -	$ 28,420,500
Science Plan					$ 8,000,000
				Total Annual Cost	$ 45,300,913
				Total Annual Cost Rounded	$ 45,000,000

Table E-34.
Framework 7410 Subprovince 1 – E1
Cost Estimates
(June 2003 Price Levels).

Item			Cost ($)
IMPLEMENTATION COSTS			
5,000 cfs diversion @ Convent / Blind River.		$	42,700,000
Sediment delivery via pipeline @ Labranche Wetlands		$	138,750,000
10,000 cfs diversion @ Bonnet Carrie spillway		$	141,600,000
Sediment delivery via pipeline @ Central Wetlands		$	151,250,000
Sediment delivery via pipeline @ Golden Triangle Area		$	138,750,000
6,000 cfs diversion @ White's Ditch		$	20,700,000
Sediment delivery via pipeline @ American / California Bay		$	363,750,000
Sediment delivery via pipeline @ Quarantine Bay		$	338,750,000
Sediment delivery via pipeline @ Fort St. Phillip		$	158,750,000
15,000 cfs diversion @ American / California Bay		$	5,000,000
15,000 cfs diversion @ Fort St. Phillip		$	4,800,000
SUBTOTAL		$	1,504,800,000
Miss. River Gulf Outlet Environmental Features & Salinity Control Study			Recommended Study
Relocations		$	3,230,000
SUBTOTAL		$	1,508,030,000
Engineering & Design (E&D) / Supervision & Administration (S&A)		$	407,168,100
Real Estate		$	171,228,000
SUBTOTAL		$	2,086,426,100
Monitoring		$	20,864,261
Adaptive Management		$	62,592,783
TOTAL IMPLEMENTATION COST		**$**	**2,169,883,144**
O&M – Structures	$ 525,346		
O&M – Implementation	$ 8,364,000		
TOTAL O & M COST	**$ 8,889,346**		

Table E-34.
Framework 7410 Subprovince 2 --M1
Cost Estimates
(June 2003 Price Levels).

Item				Cost ($)
IMPLEMENTATION COSTS				
5,000 cfs diversion @ des Allemands			$	34,700,000
des Allemands sediment enrichment			$	75,000,000
Sediment delivery via pipeline at Myrtle Grove			$	176,250,000
5,000 cfs diversion at Myrtle Grove			$	34,300,000
Barrier Island restoration at Barataria Shoreline.			$	502,460,000
Barrier Island Renourishment			$	1,127,600,000
60,000 cfs diversion @ Boothville			$	16,800,000
Sediment delivery via pipeline @ Empire			$	166,250,000
Sediment delivery via pipeline @ Bastion Bay			$	123,750,000
Sediment delivery via pipeline @ Head of Passes			$	743,750,000
Marsh creation @ Marsh creation feasibility study sites			$	300,113,000
		SUBTOTAL	$	3,300,973,000
Relocations			$	950,000
		SUBTOTAL	$	3,301,923,000
Engineering & Design (E&D) / Supervision & Administration (S&A)			$	891,519,210
Real Estate			$	312,837,000
		SUBTOTAL	$	4,506,279,210
Monitoring			$	45,062,792
Adaptive Management			$	135,188,376
		TOTAL IMPLEMENTATION COST	**$**	**4,686,530,378**
O&M - Structures	$	268,623		
O&M - Implementation	$	12,678,000		
TOTAL O & M COST	**$**	**12,946,623**		

Table E-34.
Framework 7410 Subprovince 3 - R1
Cost Estimates
(June 2003 Price Levels).

Item			Cost ($)
IMPLEMENTATION COSTS			
1,000 cfs pump @ Bayou Lafourche		$	90,000,000
Northern Terrebonne marshes			
Avoca Island Levee Diversion		$	43,300,000
Repair GIWW banks		$	44,000,000
Enlarge GIWW constrictions below Gibson & in Houma		$	26,400,000
Channel Enlargement		$	18,500,000
Freshwater intro to SW Terrebonne via Blue Hammock Bayou		$	18,500,000
Freshwater intro South of Lake Decade		$	2,200,000
Penchant Basin Plan		$	9,720,000
Relocate the navigation channel		$	93,000,000
Increase sediment transport down Wax Lake Outlet		$	16,800,000
Rebuild Historic Reefs - Pt. Au Fer to Eugene Island		$	32,800,000
Rebuild Historic Reefs - Eugene Island toward Marsh Island		$	97,000,000
Maintain land bridge between Bayous Dularge & Grand Caillou		$	8,100,000
	SUBTOTAL	$	500,320,000
Modify Old River Control Structure (ORCS) Operations Scheme to Benefit Coastal Wetlands			Recommended Study
Multi-purpose operation of the Houma Navigation Canal Lock			Included in Real Estate cost
Relocations		$	14,000,000
	SUBTOTAL	$	514,320,000
Engineering & Design (E&D) / Supervision & Administration (S&A)		$	138,866,400
Real Estate		$	80,577,000
	SUBTOTAL	$	733,763,400
Monitoring		$	7,337,634
Adaptive Management		$	22,012,902
TOTAL IMPLEMENTATION COST		**$**	**763,113,936**
O&M - Structures	$ 5,164,478		
O&M - Implementation	$ -		
TOTAL O & M COST	**$ 5,164,478**		

Table E-34.
Framework 7410 Subprovince 4 – E2
Cost Estimates
(June 2003 Price Levels).

Item		Cost ($)
IMPLEMENTATION COSTS		
Gulf Shoreline Stabilization (Mermentau Ship Channel to Rollover Bayou)	$	69,000,000
Calcasieu Ship Channel Beneficial Use	$	100,000,000
Oyster Bayou Structure (weir)	$	400,000
Long Point Structure (weir)	$	300,000
Alkali Ditch Structure (weir)	$	800,000
Black Lake Bayou Structure (weir)	$	500,000
New Lock at GIWW	$	75,000,000
Modify Cam-Creole Structures	$	600,000
FW Introduction Across Hwy 82 in Mermentau Basin (5 locations)	$	19,958,000
East Sabine HR	$	10,740,000
Black Bayou Structure (weir)	$	500,000
Hwy 82 Causeway Weir	$	8,000,000
SUBTOTAL	$	285,798,000
Relocations	$	-
SUBTOTAL	$	285,798,000
Engineering & Design (E&D) / Supervision & Administration (S&A)	$	77,165,460
Real Estate	$	21,891,000
SUBTOTAL	$	384,854,460
Monitoring	$	3,848,545
Adaptive Management	$	11,545,634
TOTAL IMPLEMENTATION COST	**$**	**400,248,638**

O&M - Structures	$	3,031,076
O&M - Implementation	$	-
TOTAL O & M COST	**$**	**3,031,076**

Table E-35.
Framework 7410
Summary of Implementation Costs.

	Sub 1	Sub 2	Sub 3	Sub 4	Total
Initial Construction Cost	$ 1,504,800,000	$ 2,098,373,000	$ 500,320,000	$ 285,798,000	$ 4,389,291,000
Continuing Construction Cost	$ -	$ 1,202,600,000	$ -	$ -	$ 1,202,600,000
Real Estate	$ 171,228,000	$ 312,837,000	$ 80,577,000	$ 21,891,000	$ 586,533,000
Relocations	$ 3,230,000	$ 950,000	$ 14,000,000	$ -	$ 18,180,000
E&D / S&A	$ 407,168,100	$ 891,519,210	$ 138,866,400	$ 77,165,460	$ 1,514,719,170
Monitoring & Adaptive Management	$ 83,457,044	$ 180,251,168	$ 29,350,536	$ 15,394,178	$ 308,452,927
Total Construction	$ 2,169,883,144	$ 4,686,530,378	$ 763,113,936	$ 400,248,638	$ 8,019,776,097
Project Implementation Reports (GI)					$ 400,988,805
PED					$ 240,593,283
				Total Cost	$ 8,661,358,185
				Total Cost Rounded	$ 8,661,000,000
Annual Costs					
O&M - Structures	$ 525,346	$ 268,623	$ 5,164,478	$ 3,031,076	$ 8,989,523
O&M - Implementation	$ 8,364,000	$ 12,678,000	$ -	$ -	$ 21,042,000
Science Plan					$ 8,000,000
				Total Annual Cost	$ 38,031,523
				Total Annual Cost Rounded	$ 38,000,000

Table E-36.
Framework 5610 Subprovince 1 – M2
Cost Estimates
(June 2003 Price Levels).

Item		Cost ($)
IMPLEMENTATION COSTS		
5,000 cfs diversion @ Convent / Blind River.	$	26,964,000
1,000 cfs diversion @ Hope Canal	$	15,300,000
10,000 cfs diversion @ White's Ditch	$	35,200,000
110,000 cfs diversion NA/California Bay	$	14,900,000
Sediment Enrichment at NA/California Bay	$	135,000,000
12,000 cfs diversion @ Bayou Lamoque	$	320,000
SUBTOTAL	$	227,684,000
Miss. River Gulf Outlet Environmental Features & Salinity Control Study		Recommended Study
Relocations	$	6,028,000
SUBTOTAL	$	233,712,000
Engineering & Design (E&D) / Supervision & Administration (S&A)	$	63,102,240
Real Estate	$	187,794,000
SUBTOTAL	$	484,608,240
Monitoring	$	4,846,082
Adaptive Management	$	14,538,247
TOTAL IMPLEMENTATION COST	**$**	**503,992,570**
O&M – Structures	$	416,236
O&M – Implementation	$	15,742,500
TOTAL O & M COST	**$**	**16,158,736**

Table E-36.
Framework 5610 Subprovince 2 --M3
Cost Estimates
(June 2003 Price Levels).

Item		Cost ($)
IMPLEMENTATION COSTS		
1,000 cfs diversion @ des Allemands		17,000,000
1,000 cfs diversion @ Donaldsonville	$	14,500,000
1,000 cfs diversion @ Pikes Peak	$	11,800,000
1,000 cfs diversion @ Edgard	$	13,100,000
75,000 cfs diversion @ Myrtle Grove	$	357,700,000
Sediment Enrichment at Myrtle Grove	$	250,000,000
60,000 cfs diversion @ Fort Jackson	$	16,800,000
Barrier Island restoration at Barataria Shoreline.	$	502,460,000
Barrier Island Renourishment	$	1,127,600,000
SUBTOTAL	$	2,310,960,000
Relocations	$	4,620,000
SUBTOTAL	$	2,315,580,000
Engineering & Design (E&D) / Supervision & Administration (S&A)	$	625,206,600
Real Estate	$	382,625,000
SUBTOTAL	$	3,323,411,600
Monitoring	$	33,234,116
Adaptive Management	$	99,702,348
TOTAL IMPLEMENTATION COST	**$**	**3,456,348,064**

O&M - Structures	$	724,406
O&M - Implementation	$	11,104,500
TOTAL O & M COST	**$**	**11,828,906**

Table E-36.
Framework 5610 Subprovince 3 - R1
Cost Estimates
(June 2003 Price Levels).

Item			Cost ($)
IMPLEMENTATION COSTS			
1,000 cfs pump @ Bayou Lafourche		$	90,000,000
Northern Terrebonne marshes			
Avoca Island Levee Diversion		$	43,300,000
Repair GIWW banks		$	44,000,000
Enlarge GIWW constrictions below Gibson & in Houma		$	26,400,000
Channel Enlargement		$	18,500,000
Freshwater intro to SW Terrebonne via Blue Hammock Bayou		$	18,500,000
Freshwater intro South of Lake Decade		$	2,200,000
Penchant Basin Plan		$	9,720,000
Relocate the navigation channel		$	93,000,000
Increase sediment transport down Wax Lake Outlet		$	16,800,000
Rebuild Historic Reefs - Pt. Au Fer to Eugene Island		$	32,800,000
Rebuild Historic Reefs - Eugene Island toward Marsh Island		$	97,000,000
Maintain land bridge between Bayous Dularge & Grand Caillou		$	8,100,000
	SUBTOTAL	$	500,320,000
Modify Old River Control Structure (ORCS) Operations Scheme to Benefit Coastal Wetlands			Recommended Study
Multi-purpose operation of the Houma Navigation Canal Lock			Included in Real Estate Costs
Relocations		$	14,000,000
	SUBTOTAL	$	514,320,000
Engineering & Design (E&D) / Supervision & Administration (S&A)		$	138,866,400
Real Estate		$	80,577,000
	SUBTOTAL	$	733,763,400
Monitoring		$	7,337,634
Adaptive Management		$	22,012,902
	TOTAL IMPLEMENTATION COST	**$**	**763,113,936**
O&M - Structures	$ 5,164,478		
O&M - Implementation	$ -		
TOTAL O & M COST	**$ 5,164,478**		

Table E-36.
Framework 5610 Subprovince 4 – E2
Cost Estimates
(June 2003 Price Levels).

Item		Cost ($)
IMPLEMENTATION COSTS		
Gulf Shoreline Stabilization (Mermentau Ship Channel to Rollover Bayou)	$	69,000,000
Calcasieu Ship Channel Beneficial Use	$	100,000,000
Oyster Bayou Structure (weir)	$	400,000
Long Point Structure (weir)	$	300,000
Alkali Ditch Structure (weir)	$	800,000
Black Lake Bayou Structure (weir)	$	500,000
New Lock at GIWW	$	75,000,000
Modify Cam-Creole Structures	$	600,000
FW Introduction Across Hwy 82 in Mermentau Basin (5 locations)	$	19,958,000
East Sabine HR	$	10,740,000
Black Bayou Structure (weir)	$	500,000
Hwy 82 Causeway Weir	$	8,000,000
SUBTOTAL	$	285,798,000
Relocations	$	-
SUBTOTAL	$	285,798,000
Engineering & Design (E&D) / Supervision & Administration (S&A)	$	77,165,460
Real Estate	$	21,891,000
SUBTOTAL	$	384,854,460
Monitoring	$	3,848,545
Adaptive Management	$	11,545,634
TOTAL IMPLEMENTATION COST	**$**	**400,248,638**
O&M - Structures	$ 3,031,076	
O&M - Implementation	$ -	
TOTAL O & M COST	**$ 3,031,076**	

Table E-37.
Framework 5610
Summary of Implementation Costs.

	Sub 1	Sub 2	Sub 3	Sub 4	Total
Initial Construction Cost	$ 92,684,000	$ 933,360,000	$ 500,320,000	$ 285,798,000	$ 1,812,162,000
Continuing Construction Cost	$ 135,000,000	$ 1,377,600,000	$ -	$ -	$ 1,512,600,000
Real Estate	$ 187,794,000	$ 382,625,000	$ 80,577,000	$ 21,891,000	$ 672,887,000
Relocations	$ 6,028,000	$ 4,620,000	$ 14,000,000	$ -	$ 24,648,000
E&D / S&A	$ 63,102,240	$ 625,206,600	$ 138,866,400	$ 77,165,460	$ 904,340,700
Monitoring & Adaptive Management	$ 19,384,330	$ 132,936,464	$ 29,350,536	$ 15,394,178	$ 197,065,508
Total Construction	$ 503,992,570	$ 3,456,348,064	$ 763,113,936	$ 400,248,638	$ 5,123,703,208
Project Implementation Reports (GI)					$ 256,185,160
PED					$ 153,711,096
				Total Cost	$ 5,533,599,465
				Total Cost Rounded	$ 5,534,000,000
Annual Costs					
O&M - Structures	$ 416,236	$ 416,236	$ 5,164,478	$ 3,031,076	$ 9,028,026
O&M - Implementation	$ 15,742,500	$ 11,104,500	$ -	$ -	$ 26,847,000
Science Plan					$ 8,000,000
				Total Annual Cost	$ 43,875,026
				Total Annual Cost Rounded	$ 44,000,000

Table E-38.
Framework 5410 Subprovince 1 – M2
Cost Estimates
(June 2003 Price Levels).

Item			Cost ($)
IMPLEMENTATION COSTS			
5,000 cfs diversion @ Convent / Blind River.		$	26,964,000
1,000 cfs diversion @ Hope Canal		$	15,300,000
10,000 cfs diversion @ White's Ditch		$	35,200,000
110,000 cfs diversion NA/California Bay		$	14,900,000
Sediment Enrichment at NA/California Bay		$	135,000,000
12,000 cfs diversion @ Bayou Lamoque		$	320,000
	SUBTOTAL	$	227,684,000
Miss. River Gulf Outlet Environmental Features & Salinity Control Study			Recommended Study
Relocations		$	6,028,000
	SUBTOTAL	$	233,712,000
Engineering & Design (E&D) / Supervision & Administration (S&A)		$	63,102,240
Real Estate		$	187,794,000
	SUBTOTAL	$	484,608,240
Monitoring		$	4,846,082
Adaptive Management		$	14,538,247
	TOTAL IMPLEMENTATION COST	**$**	**503,992,570**
O&M - Structures	$ 416,236		
O&M - Implementation	$ 15,742,500		
TOTAL O & M COST	**$ 16,158,736**		

Table E-38.
Framework 5410 Subprovince 2 --M1
Cost Estimates
(June 2003 Price Levels).

Item			Cost ($)
IMPLEMENTATION COSTS			
5,000 cfs diversion @ des Allemands		$	34,700,000
des Allemands sediment enrichment		$	75,000,000
Sediment delivery via pipeline at Myrtle Grove		$	176,250,000
5,000 cfs diversion at Myrtle Grove		$	34,300,000
Barrier Island restoration at Barataria Shoreline.		$	502,460,000
Barrier Island Renourishment		$	1,127,600,000
60,000 cfs diversion @ Ft. Jackson		$	16,800,000
Sediment delivery via pipeline @ Empire		$	166,250,000
Sediment delivery via pipeline @ Bastion Bay		$	123,750,000
Sediment delivery via pipeline @ Head of Passes		$	743,750,000
Marsh creation @ Marsh creation feasibility study sites		$	300,113,000
SUBTOTAL		$	3,300,973,000
Relocations		$	950,000
SUBTOTAL		$	3,301,923,000
Engineering & Design (E&D) / Supervision & Administration (S&A)		$	891,519,210
Real Estate		$	312,837,000
SUBTOTAL		$	4,506,279,210
Monitoring		$	45,062,792
Adaptive Management		$	135,188,376
TOTAL IMPLEMENTATION COST		**$**	**4,686,530,378**
O&M – Structures	$ 268,623		
O&M – Implementation	$ 12,678,000		
TOTAL O & M COST	**$ 12,946,623**		

Table E-38.
Framework 5410 Subprovince 3 - R1
Cost Estimates
(June 2003 Price Levels).

Item		Cost ($)
IMPLEMENTATION COSTS		
1,000 cfs pump @ Bayou Lafourche	$	90,000,000
Northern Terrebonne marshes		
Avoca Island Levee Diversion	$	43,300,000
Repair GIWW banks	$	44,000,000
Enlarge GIWW constrictions below Gibson & in Houma	$	26,400,000
Channel Enlargement	$	18,500,000
Freshwater intro to SW Terrebonne via Blue Hammock Bayou	$	18,500,000
Freshwater intro South of Lake Decade	$	2,200,000
Penchant Basin Plan	$	9,720,000
Relocate the navigation channel	$	93,000,000
Increase sediment transport down Wax Lake Outlet	$	16,800,000
Rebuild Historic Reefs – Pt. Au Fer to Eugene Island	$	32,800,000
Rebuild Historic Reefs - Eugene Island toward Marsh Island	$	97,000,000
Maintain land bridge between Bayous Dularge & Grand Caillou	$	8,100,000
SUBTOTAL	$	500,320,000
Modify Old River Control Structure (ORCS) Operations Scheme to Benefit Coastal Wetlands		Recommended Study
Multi-purpose operation of the Houma Navigation Canal Lock		Included in Real Estate Costs
Relocations	$	14,000,000
SUBTOTAL	$	514,320,000
Engineering & Design (E&D) / Supervision & Administration (S&A)	$	138,866,400
Real Estate	$	80,577,000
SUBTOTAL	$	733,763,400
Monitoring	$	7,337,634
Adaptive Management	$	22,012,902
TOTAL IMPLEMENTATION COST	**$**	**763,113,936**

Table E-38.
Framework 5410 Subprovince 3 - R1 (continued).

O&M – Structures	$	5,164,478
O&M – Implementation	$	-
TOTAL O & M COST	**$**	**5,164,478**

Table E-38.
Framework 5410 Subprovince 4 - E2
Cost Estimates
(June 2003 Price Levels).

Item			Cost ($)
IMPLEMENTATION COSTS			
Gulf Shoreline Stabilization (Mermentau Ship Channel to Rollover Bayou)		$	69,000,000
Calcasieu Ship Channel Beneficial Use		$	100,000,000
Oyster Bayou Structure (weir)		$	400,000
Long Point Structure (weir)		$	300,000
Alkali Ditch Structure (weir)		$	800,000
Black Lake Bayou Structure (weir)		$	500,000
New Lock at GIWW		$	75,000,000
Modify Cam-Creole Structures		$	600,000
FW Introduction Across Hwy 82 in Mermentau Basin (5 locations)		$	19,958,000
East Sabine HR		$	10,740,000
Black Bayou Structure (weir)		$	500,000
Hwy 82 Causeway Weir		$	8,000,000
	SUBTOTAL	$	285,798,000
Relocations		$	-
	SUBTOTAL	$	285,798,000
Engineering & Design (E&D) / Supervision & Administration (S&A)		$	77,165,460
Real Estate		$	21,891,000
	SUBTOTAL	$	384,854,460
Monitoring		$	3,848,545
Adaptive Management		$	11,545,634
	TOTAL IMPLEMENTATION COST	**$**	**400,248,638**

O&M - Structures	$	3,031,076
O&M - Implementation	$	-
TOTAL O & M COST	**$**	**3,031,076**

Table E-39.
Framework 5410
Summary of Implementation Costs.

	Sub 1	Sub 2	Sub 3	Sub 4	Total
Initial Construction Cost	$ 92,684,000	$ 2,098,373,000	$ 500,320,000	$ 285,798,000	$ 2,977,175,000
Continuing Construction Cost	$ 135,000,000	$ 1,202,600,000	$ -	$ -	$ 1,337,600,000
Real Estate	$ 187,794,000	$ 312,837,000	$ 80,577,000	$ 21,891,000	$ 603,099,000
Relocations	$ 6,028,000	$ 950,000	$ 14,000,000	$ -	$ 20,978,000
E&D / S&A	$ 63,102,240	$ 891,519,210	$ 138,866,400	$ 77,165,460	$ 1,170,653,310
Monitoring & Adaptive Management	$ 19,384,330	$ 180,251,168	$ 29,350,536	$ 15,394,178	$ 244,380,212
Total Construction	$ 503,992,570	$ 4,686,530,378	$ 763,113,936	$ 400,248,638	$ 6,353,885,522
Project Implementation Reports (GI)					$ 317,694,276
PED					$ 190,616,566
				Total Cost	$ 6,862,196,364
				Total Cost Rounded	$ 6,862,000,000
Annual Costs					
O&M - Structures	$ 416,236	$ 268,623	$ 5,164,478	$ 3,031,076	$ 8,880,413
O&M - Implementation	$ 15,742,500	$ 12,678,000	$ -	$ -	$ -
Science Plan					$ 8,000,000
				Total Annual Cost	$ 16,880,413
				Total Annual Cost Rounded	$ 17,000,000

Table E-40.
Framework 7610 Subprovince 1 -- E1
Cost Estimates
(June 2003 Price Levels).

Item				Cost ($)
IMPLEMENTATION COSTS				
5,000 cfs diversion @ Convent / Blind River.				42,700,000
Sediment delivery via pipeline @ Labranche Wetlands			$	138,750,000
10,000 cfs diversion @ Bonnet Carrie spillway			$	141,600,000
Sediment delivery via pipeline @ Central Wetlands			$	151,250,000
Sediment delivery via pipeline @ Golden Triangle Area			$	138,750,000
6,000 cfs diversion @ White's Ditch			$	20,700,000
Sediment delivery via pipeline @ American / California Bay			$	363,750,000
Sediment delivery via pipeline @ Quarantine Bay			$	338,750,000
Sediment delivery via pipeline @ Fort St. Phillip			$	158,750,000
15,000 cfs diversion @ American / California Bay			$	5,000,000
15,000 cfs diversion @ Fort St. Phillip			$	4,800,000
		SUBTOTAL	$	1,504,800,000
Miss. River Gulf Outlet Environmental Features & Salinity Control Study				Recommended Study
Relocations			$	3,230,000
		SUBTOTAL	$	1,508,030,000
Engineering & Design (E&D) / Supervision & Administration (S&A)			$	407,168,100
Real Estate			$	171,228,000
		SUBTOTAL	$	2,086,426,100
Monitoring			$	20,864,261
Adaptive Management			$	62,592,783
		TOTAL IMPLEMENTATION COST	**$**	**2,169,883,144**
O&M – Structures	$	525,346		
O&M – Implementation	$	8,364,000		
TOTAL O & M COST	**$**	**8,889,346**		

Table E-40.
Framework 7610 Subprovince 2 --M3
Cost Estimates
(June 2003 Price Levels).

Item		Cost ($)
IMPLEMENTATION COSTS		
1,000 cfs diversion @ des Allemands	$	17,000,000
1,000 cfs diversion @ Donaldsonville	$	14,500,000
1,000 cfs diversion @ Pikes Peak	$	11,800,000
1,000 cfs diversion @ Edgard	$	13,100,000
75,000 cfs diversion @ Myrtle Grove	$	357,700,000
Sediment Enrichment at Myrtle Grove	$	250,000,000
60,000 cfs diversion @ Fort Jackson	$	16,800,000
Barrier Island restoration at Barataria Shoreline.	$	502,460,000
Barrier Island Renourishment	$	1,127,600,000
SUBTOTAL	$	2,310,960,000
Relocations	$	4,620,000
SUBTOTAL	$	2,315,580,000
Engineering & Design (E&D) / Supervision & Administration (S&A)	$	625,206,600
Real Estate	$	382,625,000
SUBTOTAL	$	3,323,411,600
Monitoring	$	33,234,116
Adaptive Management	$	99,702,348
TOTAL IMPLEMENTATION COST	**$**	**3,456,348,064**

O&M - Structures	$	724,406
O&M - Implementation	$	11,104,500
TOTAL O & M COST	**$**	**11,828,906**

Table E-40.
Framework 7610 Subprovince 3 - R1
Cost Estimates
(June 2003 Price Levels).

Item				Cost ($)
IMPLEMENTATION COSTS				
1,000 cfs pump @ Bayou Lafourche			$	90,000,000
Northern Terrebonne marshes				
Avoca Island Levee Diversion			$	43,300,000
Repair GIWW banks			$	44,000,000
Enlarge GIWW constrictions below Gibson & in Houma			$	26,400,000
Channel Enlargement			$	18,500,000
Freshwater intro to SW Terrebonne via Blue Hammock Bayou			$	18,500,000
Freshwater intro South of Lake Decade			$	2,200,000
Penchant Basin Plan			$	9,720,000
Relocate the navigation channel			$	93,000,000
Increase sediment transport down Wax Lake Outlet			$	16,800,000
Rebuild Historic Reefs - Pt. Au Fer to Eugene Island			$	32,800,000
Rebuild Historic Reefs - Eugene Island toward Marsh Island			$	97,000,000
Maintain land bridge between Bayous Dularge & Grand Caillou			$	8,100,000
		SUBTOTAL	$	500,320,000
Modify Old River Control Structure (ORCS) Operations Scheme to Benefit Coastal Wetlands				Recommended Study
Multi-purpose operation of the Houma Navigation Canal Lock				Included in Real Estate Costs
Relocations			$	14,000,000
		SUBTOTAL	$	514,320,000
Engineering & Design (E&D) / Supervision & Administration (S&A)			$	138,866,400
Real Estate			$	80,577,000
		SUBTOTAL	$	733,763,400
Monitoring			$	7,337,634
Adaptive Management			$	22,012,902
TOTAL IMPLEMENTATION COST			**$**	**763,113,936**
O&M – Structures	$	5,164,478		
O&M – Implementation	$	-		
TOTAL O & M COST	**$**	**5,164,478**		

Table E-40.
Framework 7610 Subprovince 4 - E2
Cost Estimates
(June 2003 Price Levels).

Item		Cost ($)
IMPLEMENTATION COSTS		
Gulf Shoreline Stabilization (Mermentau Ship Channel to Rollover Bayou)	$	69,000,000
Calcasieu Ship Channel Beneficial Use	$	100,000,000
Oyster Bayou Structure (weir)	$	400,000
Long Point Structure (weir)	$	300,000
Alkali Ditch Structure (weir)	$	800,000
Black Lake Bayou Structure (weir)	$	500,000
New Lock at GIWW	$	75,000,000
Modify Cam-Creole Structures	$	600,000
FW Introduction Across Hwy 82 in Mermentau Basin (5 locations)	$	19,958,000
East Sabine HR	$	10,740,000
Black Bayou Structure (weir)	$	500,000
Hwy 82 Causeway Weir	$	8,000,000
SUBTOTAL	$	285,798,000
Relocations	$	-
SUBTOTAL	$	285,798,000
Engineering & Design (E&D) / Supervision & Administration (S&A)	$	77,165,460
Real Estate	$	21,891,000
SUBTOTAL	$	384,854,460
Monitoring	$	3,848,545
Adaptive Management	$	11,545,634
TOTAL IMPLEMENTATION COST	**$**	**400,248,638**

O&M - Structures	$	3,031,076
O&M - Implementation	$	-
TOTAL O & M COST	**$**	**3,031,076**

Table E-41.
Framework 7610
Summary of Implementation Costs.

	Sub 1	Sub 2	Sub 3	Sub 4	Total
Initial Construction Cost	$ 1,504,800,000	$ 933,360,000	$ 500,320,000	$ 285,798,000	$ 3,224,278,000
Continuing Construction Cost	$ -	$ 1,377,600,000	$ -	$ -	$ 1,377,600,000
Real Estate	$ 171,228,000	$ 382,625,000	$ 80,577,000	$ 21,891,000	$ 656,321,000
Relocations	$ 3,230,000	$ 4,620,000	$ 14,000,000	$ -	$ 21,850,000
E&D / S&A	$ 407,168,100	$ 625,206,600	$ 138,866,400	$ 77,165,460	$ 1,248,406,560
Monitoring & Adaptive Management	$ 83,457,044	$ 132,936,464	$ 29,350,536	$ 15,394,178	$ 261,138,222
Total Construction	$ 2,169,883,144	$ 3,456,348,064	$ 763,113,936	$ 400,248,638	$ 6,789,593,782
Project Implementation Reports (GI)					$ 339,479,689
PED					$ 203,687,813
				Total Cost	$ 7,332,761,285
				Total Cost Rounded	$ 7,333,000,000
Annual Costs					
O&M - Structures	$ 525,346	$ 724,406	$ 5,164,478	$ 3,031,076	$ 9,445,306
O&M - Implementation	$ 8,364,000	$ 11,104,500	$ -	$ -	$ 19,468,500
Science Plan					$ 8,000,000
				Total Annual Cost	$ 36,913,806
				Total Annual Cost Rounded	$ 37,000,000

Table E-42.
Framework 7002 Subprovince 1 – E1
Cost Estimates
(June 2003 Price Levels).

Item				Cost ($)
IMPLEMENTATION COSTS				
5,000 cfs diversion @ Convent / Blind River.			$	42,700,000
Sediment delivery via pipeline @ Labranche Wetlands			$	138,750,000
10,000 cfs diversion @ Bonnet Carrie spillway			$	141,600,000
Sediment delivery via pipeline @ Central Wetlands			$	151,250,000
Sediment delivery via pipeline @ Golden Triangle Area			$	138,750,000
6,000 cfs diversion @ White's Ditch			$	20,700,000
Sediment delivery via pipeline @ American / California Bay			$	363,750,000
Sediment delivery via pipeline @ Quarantine Bay			$	338,750,000
Sediment delivery via pipeline @ Fort St. Phillip			$	158,750,000
15,000 cfs diversion @ American / California Bay			$	5,000,000
15,000 cfs diversion @ Fort St. Phillip			$	4,800,000
		SUBTOTAL	$	1,504,800,000
Miss. River Gulf Outlet Environmental Features & Salinity Control Study				Recommended Study
Relocations			$	3,230,000
		SUBTOTAL	$	1,508,030,000
Engineering & Design (E&D) / Supervision & Administration (S&A)			$	407,168,100
Real Estate			$	171,228,000
		SUBTOTAL	$	2,086,426,100
Monitoring			$	20,864,261
Adaptive Management			$	62,592,783
		TOTAL IMPLEMENTATION COST	**$**	**2,169,883,144**
O&M - Structures	$	525,346		
O&M - Implementation	$	8,364,000		
TOTAL O & M COST	**$**	**8,889,346**		

Table E-42.
Framework 7002 Subprovince 2 --E3
Cost Estimates
(June 2003 Price Levels).

Item			Cost ($)
IMPLEMENTATION COSTS			
5,000 cfs diversion @ des Allemands w/sediment enrichment		$	34,700,000
des Allemands sediment enrichment		$	75,000,000
Mississippi River Third Delta (Subprovinces 2 & 3)		$	3,505,000,000
Mississippi River Third Delta sediment enrichment		$	250,000,000
Marsh creation @ Marsh creation feasibility study sites		$	300,113,000
90,000 cfs diversion @ Fort Jackson		$	21,300,000
Fort Jackson sediment enrichment		$	135,000,000
Relocation of Deep Draft Navigation Channel		$	1,115,000,000
Barrier Island restoration @ Barataria Shoreline (3,000')		$	502,460,000
Barrier Island Renourishment		$	1,127,600,000
	SUBTOTAL	$	7,066,173,000
Mississippi River Third Delta			Cost to be verified in recommended study
Relocation of Deep Draft Navigation Channel			Cost to be verified in recommended study
Relocations		$	92,550,000
	SUBTOTAL	$	7,158,723,000
Engineering & Design (E&D) / Supervision & Administration (S&A)		$	1,932,855,210
Real Estate		$	343,688,000
	SUBTOTAL	$	9,435,266,210
Monitoring		$	94,352,662
Adaptive Management		$	283,057,986
	TOTAL IMPLEMENTATION COST	**$**	**9,812,676,858**
O&M - Structures	$ 7,964,363		
O&M - Implementation	$ 21,520,500		
TOTAL O & M COST	**$ 29,484,863**		

Table E-42.
Framework 7002 Subprovince 3 - M1
Cost Estimates
(June 2003 Price Levels).

Item		Cost ($)	
IMPLEMENTATION COSTS			
Mississippi River Third Delta (Subprovinces 2 & 3)		See Costs for Framework S3 M1	
Mississippi River Third Delta sediment enrichment		See Costs for Framework S3 M1	
1,000 cfs pump @ Bayou Lafourche		$	90,000,000
Relocate the navigation channel		$	93,000,000
Increase sediment transport down Wax Lake Outlet		$	16,800,000
Rebuild historic barrier between Point Au Fer and Eugene Island		$	32,800,000
Rebuild Historic Reefs along the historic Point Au Fer barrier reef from Eugene Island extending towards Marsh Island to the west		$	97,000,000
Northern Terrebonne marshes			
Avoca Island Levee Diversion		$	43,300,000
Repair GIWW banks		$	44,000,000
Enlarge GIWW constrictions below Gibson & in Houma		$	26,400,000
Channel Enlargement		$	18,500,000
Freshwater intro to SW Terrebonne via Blue Hammock Bayou		$	18,500,000
Freshwater intro South of Lake Decade		$	2,200,000
Penchant Basin Plan		$	9,720,000
Stabilize banks of Southwest Pass		$	218,000,000
Maintain northern shorelines of East Cote Blanche Bay		$	9,100,000
Rebuild Historic Pointe Chevreuil Reef toward Marsh Island		$	76,600,000
Rehabilitate Terrebonne barrier islands		$	232,800,000
Renourish Terrebonne Barrier Islands		$	499,500,000
Rehabilitate northern shorelines of Terrebonne/Timbalier Bays		$	39,000,000
Backfill pipeline canals		$	179,000,000
Maintain land bridge between Bayous Dularge & Grand Caillou		$	8,100,000
Maintain the land bridge between Caillou Lake and the gulf		$	41,000,000
Stabilize gulf shoreline		$	32,000,000
Maintain Timbalier land bridge		$	581,000,000
	SUBTOTAL	$	2,408,320,000
Mississippi River Third Delta		Cost to be verified through additional study	
Study the modification of the Old River Control Structure (ORCS) Operational Scheme to Benefit Coastal Wetlands		Recommended Study	
Multi-purpose operation of the Houma Navigation Canal Lock		Included in Real Estate cost	
Relocations		$	14,000,000
	SUBTOTAL	$	2,422,320,000

Table E-42.
Framework 7002 Subprovince 3 - M1 (continued).

Engineering & Design (E&D) / Supervision & Administration (S&A)			$	654,026,400
Real Estate			$	171,883,000
SUBTOTAL			$	3,248,229,400
Monitoring			$	32,482,294
Adaptive Management			$	97,446,882
TOTAL IMPLEMENTATION COST			**$**	**3,378,158,576**
O&M - Structures	$	10,751,617		
O&M - Implementation	$	-		
TOTAL O & M COST	**$**	**10,751,617**		

Table E-42.
Framework 7002 Subprovince 4 - E2
Cost Estimates
(June 2003 Price Levels).

Item			Cost ($)
IMPLEMENTATION COSTS			
Gulf Shoreline Stabilization (Mermentau Ship Channel to Rollover Bayou)		$	69,000,000
Calcasieu Ship Channel Beneficial Use		$	100,000,000
Oyster Bayou Structure (weir)		$	400,000
Long Point Structure (weir)		$	300,000
Alkali Ditch Structure (weir)		$	800,000
Black Lake Bayou Structure (weir)		$	500,000
New Lock at GIWW		$	75,000,000
Modify Cam-Creole Structures		$	600,000
FW Introduction Across Hwy 82 in Mermentau Basin (5 locations)		$	19,958,000
East Sabine HR		$	10,740,000
Black Bayou Structure (weir)		$	500,000
Hwy 82 Causeway Weir		$	8,000,000
SUBTOTAL		$	285,798,000
Relocations		$	-
SUBTOTAL		$	285,798,000
Engineering & Design (E&D) / Supervision & Administration (S&A)		$	77,165,460
Real Estate		$	21,891,000
SUBTOTAL		$	384,854,460
Monitoring		$	3,848,545
Adaptive Management		$	11,545,634
TOTAL IMPLEMENTATION COST		**$**	**400,248,638**
O&M – Structures	$ 3,031,076		
O&M – Implementation	$ -		
TOTAL O & M COST	**$ 3,031,076**		

Table E-43.
Framework 7002
Summary of Implementation Costs.

	Sub 1	Sub 2	Sub 3	Sub 4	Total
Initial Construction Cost	$ 1,504,800,000	$ 5,478,573,000	$ 1,908,820,000	$ 285,798,000	$ 9,177,991,000
Continuing Construction Cost	$ -	$ 1,587,600,000	$ 499,500,000	$ -	$ 2,087,100,000
Real Estate	$ 171,228,000	$ 343,688,000	$ 171,883,000	$ 21,891,000	$ 708,690,000
Relocations	$ 3,230,000	$ 92,550,000	$ 14,000,000	$ -	$ 109,780,000
E&D / S&A	$ 407,168,100	$ 1,932,855,210	$ 654,026,400	$ 77,165,460	$ 3,071,215,170
Monitoring & Adaptive Management	$ 83,457,044	$ 377,410,648	$ 129,929,176	$ 15,394,178	$ 606,191,047
Total Construction	$ 2,169,883,144	$ 9,812,676,858	$ 3,378,158,576	$ 400,248,638	$ 15,760,967,217
Project Implementation Reports (GI)					$ 788,048,361
PED					$ 472,829,017
				Total Cost	$ 17,021,844,594
				Total Cost Rounded	$ 17,022,000,000
Annual Costs					
O&M - Structures	$ 525,346	$ 7,964,363	$ 10,751,617	$ 3,031,076	$ 22,272,402
O&M - Implementation	$ 8,364,000	$ 21,520,500	$ -	$ -	$ 29,884,500
Science Plan					$ 8,000,000
				Total Annual Cost	$ 60,156,902
				Total Annual Cost Rounded	$ 60,000,000

Table E-44.
Subprovince 1 – Modified Supplemental Framework 10130 (M2 modified)
Cost Estimates
(June 2003 Price Levels).

Item			Cost ($)
IMPLEMENTATION COSTS			
5,000 cfs diversion @ Convent / Blind River.		$	26,964,000
1,000 cfs diversion @ Hope Canal		$	15,300,000
10,000 cfs diversion @ White's Ditch		$	35,200,000
110,000 cfs diversion NA/California Bay		$	14,900,000
Sediment Enrichment at NA/California Bay		$	135,000,000
12,000 cfs diversion @ Bayou Lamoque		$	320,000
Amite River diversion (spoil banks gapping)		$	2,855,000
Sediment delivery via pipeline at Labranche Wetlands		$	138,750,000
Rehab. Violet Siphon proj. for enhanced influence in Central Wetlands		$	11,800,000
Marsh nourishment on land bridge separating L. Pontchartrain and L. Borgne		$	71,100,000
	SUBTOTAL	$	452,189,000
Divert water from IHNC to Central Wetlands			Addressed under separate authority
Caernarvon - optimize for marsh creation (reauthorization project)			To Be Identified by Additional Study
MRGO include environmental restoration / Seabrook control struc.			Recommended Study
Bonne Carre - opportunistic use			Authorized under CWPPRA
Relocations		$	6,028,000
	SUBTOTAL	$	458,217,000
Engineering & Design (E&D) / Supervision & Administration (S&A)		$	123,718,590
Real Estate		$	201,813,000
	SUBTOTAL	$	783,748,590
Monitoring		$	7,837,486
Adaptive Management		$	23,512,458
	TOTAL IMPLEMENTATION COST	**$**	**815,098,534**

O&M - Structures	$	516,200
O&M - Implementation	$	15,742,500
TOTAL O & M COST	**$**	**16,258,700**

Table E-44.
Subprovince 2 -- Modified Supplemental Framework 10130 (R1)
Cost Estimates
(June 2003 Price Levels).

Item			Cost ($)
IMPLEMENTATION COSTS			
1,000 cfs diversion at Lac des Allemands		$	17,000,000
1,000 cfs diversion at Donaldsonville		$	14,500,000
1,000 cfs diversion at Pikes Peak		$	11,800,000
1,000 cfs diversion at Edgard		$	13,100,000
Sediment delivery via pipeline at Myrtle Grove		$	112,000,000
Myrtle Grove diversion 5,000 cfs		$	34,300,000
60,000 cfs diversion @ Boothville		$	16,800,000
Boothville Sediment Enrichment		$	122,700,000
Barrier Island restoration at Barataria Shoreline.		$	502,460,000
Barrier Island Renourishment		$	1,127,600,000
Marsh Creation Study Sites		$	300,113,000
	SUBTOTAL	$	2,272,373,000
Reauthorization of Davis Pond		To Be Identified by Additional Study	
Mississippi River Delta Management Study		Recommended Study	
Third Delta (recognize as part of national LCA plan, critical to attaining restoration scales, but too early to include in evaluation of this plan)		Recommended Study	
Relocations		$	4,260,000
	SUBTOTAL	$	2,276,633,000
Engineering & Design (E&D) / Supervision & Administration (S&A)		$	614,690,910
Real Estate		$	267,754,000
	SUBTOTAL	$	3,159,077,910
Monitoring		$	31,590,779
Adaptive Management		$	94,772,337
	TOTAL IMPLEMENTATION COST	**$**	**3,285,441,026**

O&M – Structures	$	844,689
O&M - Implementation	$	12,678,000
TOTAL O & M COST	**$**	**13,522,689**

Table E-44.
Subprovince 3 – Modified Supplemental Framework 10130 (R1 modified)
Cost Estimates.

Item			Cost ($)
IMPLEMENTATION COSTS			
1,000 cfs pump @ Bayou Lafourche		$	90,000,000
Relocate the navigation channel		$	93,000,000
Increase sediment transport down Wax Lake Outlet		$	16,800,000
Northern Terrebonne marshes			
Avoca Island Levee Diversion		$	43,300,000
Repair GIWW banks		$	44,000,000
Enlarge GIWW constrictions below Gibson & in Houma		$	26,400,000
Channel Enlargement		$	18,500,000
Freshwater intro to SW Terrebonne via Blue Hammock Bayou		$	18,500,000
Penchant Basin Plan		$	9,720,000
Maintain Northern Shore of Cote Blanche Bay at Pointe Marone		$	9,100,000
Rebuild Historic Pointe Chevreuil Reef toward Marsh Island		$	76,600,000
Restore Terrebonne Barrier Islands		$	232,800,000
Renourish Terrebonne Barrier Islands		$	499,500,000
Maintain Land Bridge between Sister Lake & Gulf of Mexico		$	41,000,000
Stabilize Gulf Shoreline at Pointe Au Fer Island		$	32,000,000
Maintain land bridge between Bayous Dularge & Grand Caillou		$	8,100,000
	SUBTOTAL	$	1,259,320,000
Modify Old River Control Structure (ORCS) Operations Scheme to Benefit Coastal Wetlands		Recommended Study	
Multi-purpose operation of the Houma Navigation Canal Lock			Included in Real Estate Costs
Relocations		$	14,000,000
	SUBTOTAL	$	1,273,320,000
Engineering & Design (E&D) / Supervision & Administration (S&A)		$	343,796,400
Real Estate		$	88,097,000
	SUBTOTAL	$	1,705,213,400
Monitoring		$	17,052,134
Adaptive Management		$	51,156,402
TOTAL IMPLEMENTATION COST		**$**	**1,773,421,936**

O&M - Structures	$	4,577,325
O&M - Implementation	$	-
TOTAL O & M COST	**$**	**4,577,325**

Table E-44.
Subprovince 4 - Modified Supplemental Framework 10130 (E2 modified)
Cost Estimates
(June 2003 Price Levels).

Item			Cost ($)
IMPLEMENTATION COSTS			
Salinity Control at Oyster Bayou Structure		$	400,000
Salinity Control at Long Point Structure		$	300,000
Salinity Control at Alkali Ditch Structure		$	800,000
Salinity Control at Black Lake Bayou Structure		$	500,000
Modify Cam-Creole Structures		$	600,000
FW Introduction Across Hwy 82 in Mermentau Basin (5 locations)		$	19,958,000
East Sabine HR		$	10,740,000
Black Bayou Structure (weir)		$	500,000
Causeway Weir		$	8,000,000
Calcasieu Ship Channel Beneficial Use		$	100,000,000
Gulf Shoreline Stabilization (Mermentau Ship Channel to Rollover Bayou)		$	69,000,000
Black Bayou Culvert Freshwater Introduction		$	5,600,000
	SUBTOTAL	$	216,398,000
Chenier Plain Freshwater Management and Allocation Reassessment			Recommended Study
Relocations		$	-
	SUBTOTAL	$	216,398,000
Engineering & Design (E&D) / Supervision & Administration (S&A)		$	58,427,460
Real Estate		$	21,794,000
	SUBTOTAL	$	296,619,460
Monitoring		$	2,966,195
Adaptive Management		$	8,898,584
	TOTAL IMPLEMENTATION COST	**$**	**308,484,238**
O&M - Structures	$ 1,960,233		
O&M - Implementation	$ -		
TOTAL O&M COST	**$ 1,960,233**		

Table E-45.
Modified Supplemental Framework 10130
Summary of Implementation Costs.

	Sub 1	Sub 2	Sub 3	Sub 4	Total
Initial Construction Cost	$ 317,189,000	$ 1,022,073,000	$ 759,820,000	$ 216,398,000	$ 2,315,480,000
Continuing Construction Cost	$ 135,000,000	$ 1,250,300,000	$ 499,500,000	$ -	$ 1,884,800,000
Real Estate	$ 201,813,000	$ 267,754,000	$ 88,097,000	$ 21,794,000	$ 579,458,000
Relocations	$ 6,028,000	$ 4,260,000	$ 14,000,000	$ -	$ 24,288,000
E&D / S&A	$ 123,718,590	$ 614,690,910	$ 343,796,400	$ 58,427,460	$ 1,140,633,360
Monitoring & Adaptive Management	$ 31,349,944	$ 126,363,116	$ 68,208,536	$ 11,864,778	$ 237,786,374
Total Construction	$ 815,098,534	$ 3,285,441,026	$ 1,773,421,936	$ 308,484,238	$ 6,182,445,734
Project Implementation Reports (GI)					$ 309,122,287
PED					$ 185,473,372
				Total Cost	$ 6,677,041,393
				Total Cost Rounded	$ 6,677,000,000
Annual Costs					
O&M - Structures	$ 516,200	$ 844,689	$ 4,577,325	$ 1,960,233	$ 7,898,447
O&M - Implementation	$ 15,742,500	$ 12,678,000	$ -	$ -	$ 28,420,500
Science Plan					$ 8,000,000
				Total Annual Cost	$ 44,318,947
				Total Annual Cost Rounded	$ 44,000,000